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# INCREMENTAL COSTS OF RESIDENTIAL ENERGY CONSERVATION COMPONENTS AND SYSTEMS

**PREPARED FOR:**

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## SUMMARY

The incremental costs of over 100 residential energy conservation components and systems were calculated using data obtained from the construction of the 24 houses in the Flair Homes Energy Demo/Canadian Home Builders' Association Flair Mark XIV Project in Winnipeg. These included many building envelope, airtightness and mechanical system components commonly used in R-2000 construction. Costs were calculated using a conventional 97 $m^2$ (1040 $ft^2$) bungalow with a full basement as a reference structure. The incremental costs were defined as those incurred by the builder beyond those normally encountered using conventional construction practices. Material costs and labour rates were obtained from local suppliers and sub-trades. No provisions were made for overhead, profit or learning time because of the significant variations which can occur among builders, locations, etc.

Four types of wall systems were studied: 2x6 frame walls, frame walls with exterior insulated sheathing, frame walls with interior strapping and double wall construction. Insulation values ranged from RSI 3.43 to RSI 7.04 (R-19.5 to R-40). Incremental costs were calculated relative to both 38x89 (2x4) and 38x140 (2x6) construction. Thirteen basement insulation systems were investigated including interior, exterior and sub-slab insulation techniques. Eight ceiling insulation levels were analyzed, ranging from RSI 7.93 to RSI 10.57 (R-45 to R-60).

Thirteen window systems were investigated ranging from standard double and triple-glazed units to windows which incorporated multiple features to improve their thermal performance. This data was refined to estimate the costs of triple-glazing, butyl/metal spacers, argon gas fills, low E films and reflective glazing films.

The incremental costs of various envelope air leakage sealing methods were determined by defining 25 "airtightness components" for specific building envelope elements. These were assembled in various combinations to form complete "airtightness systems". These included both the polyethylene air/vapour barrier system and the Airtight Drywall Approach.

Eleven ventilation system components were studied ranging from simple fresh air intakes to Heat Recovery Ventilators. These components were assembled into eight distinct ventilation systems and their incremental costs determined. Heating system costs were calculated relative to a conventional, naturally aspirated gas furnace. Five different heating system options were studied as well as ductwork and air-conditioning options plus two integrated heating, ventilation and hot water heating systems.

Based on the results of the study, recommendations were developed for priorizing energy conservation options in R-2000 housing using their relative cost effectiveness to rank the options.

## RÉSUMÉ

On a calculé les coûts différentiels de plus de 100 composants et systèmes éconergétiques résidentiels, en utilisant des données issues des caractéristiques de construction des 24 maisons du Projet de démonstration de la maison à haut rendement énergétique/Mark XIV de l'ACCH, de Flair, à Winnipeg, ce qui incluait plusieurs composants d'enveloppe du bâtiment, de systèmes d'étanchéité à l'air et d'installations mécaniques utilisés couramment dans la construction des maisons R-2000. Les coûts ont été calculés en fonction d'une construction de référence de type bungalow classique de 97 $m^2$ (1 040 $pi^2$), dotée d'un sous-sol pleine grandeur. Les coûts différentiels ont été définis comme étant les coûts encourus par le constructeur en supplément de ceux qui sont habituellement encourus selon les méthodes de construction classiques. Les coûts en matériaux et les taux de main-d'oeuvre ont été obtenus auprès des fournisseurs et des sous-traitants locaux. On n'a pas tenu compte des frais généraux, des marges bénéficiaires ni du temps d'apprentissage, en raison des écarts appréciables que l'on note à ce titre parmi les différents constructeurs, les emplacements, etc.

Quatre (4) types de mur ont été étudiés : les murs en pan de bois de 2 x 6, les murs en pan de bois avec revêtement isolés par l'extérieur, les murs en pan de bois avec fourrure intérieure et les constructions de type à murs doubles. Les valeurs d'isolation thermique étaient de RSI 3.43 à RSI 7.04 (R-19.5 à R-40). Les coûts différentiels ont été calculés en fonction d'une construction de type 38 x 39 (2 x 4) et d'une construction de type 38 x 140 (2 x 6). On a étudié treize (13) systèmes d'isolation thermique de sous-sol, y compris les techniques d'isolation par l'intérieur, par l'extérieur et par dessous les dalles. Huit (8) niveaux d'isolation de plafond ont été analysés, soit de RSI 7.93 à RSI 10.57 (R-45 à R-60).

Treize (13) systèmes de fenêtre ont été étudiés, depuis les unités standard à vitrage double et à vitrage triple jusqu'aux fenêtres dans lesquelles sont incorporées des caractéristiques multiples ayant pour but d'améliorer le rendement thermique. On a raffiné ces données en vue d'estimer les coûts reliés aux vitrages triples, aux cales d'espacement en butyle/métal, aux remplissages d'argon gazeux, aux pellicules à faible énergie et aux pellicules de vitrage réfléchissantes.

On a déterminé les coûts différentiels de diverses méthodes d'étanchéité aux infiltrations et exfiltrations dans l'enveloppe en définissant 25 «composants d'étanchéité à l'air» pour des éléments spécifiques de l'enveloppe du bâtiment. On a regroupé ces composants selon diverses combinaisons afin de constituer des «systèmes étanches à l'air» complets, qui comprenaient les systèmes pare-air/vapeur en polyéthylène comme les systèmes basés sur la méthode des murs secs étanches à l'air.

Onze (11) composants d'installation de ventilation ont été étudiées, qui allaient des simples prises d'air extérieur aux ventilateurs échangeurs de chaleur. Ces composants ont été assemblés dans huit (8) systèmes de ventilation distincts, et leurs coûts différentiels ont été déterminés. On a calculé les coûts des installations de chauffage en se basant sur un générateur d'air chaud à gaz à aspiration naturelle de type classique. On a étudié cinq (5) choix différents de système de chauffage ainsi que des options de réseaux de conduits et de conditionnement d'air, plus deux (2) installations de chauffage et de ventilation intégrés et de chauffage à l'eau chaude.

Suivant les résultate de l'étude, des recommandations ont été mises au point en vue de hiérarchiser les différentes options d'économie d'énergie dans les maisons R-2000 selon leur rentabilité relative.

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## SECTION 1

## INTRODUCTION

### 1.1 BACKGROUND

The trend by the Canadian home building industry towards improved energy conservation practices has produced an abundance of design options for new construction. Until recently, the insulation, airtightness, heating, ventilation and other energy-related aspects of house design were fairly conventional and unchanging with time. Today, the builder is faced with numerous, products, systems and alternatives for each component. For example, exterior walls were usually constructed with 38x89 (2x4) framing and RSI 2.11 (R-12) insulation. Today, this basic wall design is still employed although, in most areas, 38x140 (2x6) construction with RSI 3.52 (R-20) insulation is the norm. Other systems now frequently used include frame walls with exterior insulated sheathing, interior strapped walls and double wall construction. The number of mechanical system options has also grown, especially those dealing with ventilation. A "ventilation system" was once assumed to be a simple bathroom fan; now there are central exhaust systems, Heat Recovery Ventilators and integrated systems in which the ventilation, hot water and space heating functions are performed by one appliance.

What then, are the implications to the builder? On the positive side, increased options mean greater flexibility in design and an enhanced ability to tailor the house to the marketplace. On the negative side, more options mean more decisions have to be made in the design phase and new construction techniques have to be learned and applied on the job site.

The two major technical parameters which govern the selection of competing conservation options are cost and performance (although others such as marketability, product availability, etc. may also be important). It is this first issue, the incremental cost of energy conservation components and systems, which is the subject of this report.

This report replaces an earlier version entitled "Incremental Costs of Energy Conservation Systems" (Proskiw 1988).

### 1.2 THE FLAIR HOMES ENERGY DEMO/CHBA FLAIR MARK XIV PROJECT

The work described in this report was conducted as part of the Flair Homes Energy Demo/CHBA Flair Mark XIV Project. This project was created in 1985 to provide a demonstration of various energy conservation technologies, products and systems which might be suitable for the Canadian home building industry.

The specific objectives of the project were:

1. To demonstrate and evaluate the performance of various low energy building envelope systems.

2. To demonstrate and evaluate the performance of various space heating, hot water heating and mechanical ventilation systems.

3. To transfer the knowledge gained in the project to the Canadian home building industry.

Support for the project was provided by Energy, Mines and Resources Canada under the Energy Demo Program and by Manitoba Energy and Mines under the Manitoba/Canada Conservation and Renewable Energy Demonstration Agreement (CREDA). Project management was the responsibility of Flair Homes (Manitoba) Ltd. Project monitoring and reporting were performed by UNIES Ltd., consulting engineers, of Winnipeg.

The project was also designed to provide technical support to the R-2000 Home Program, which is funded by Energy, Mines and Resources Canada and administered by the Canadian Home Builders Association (CHBA). The CHBA's "Mark XIV" designation was acquired when a major portion of the research priorities identified by the CHBA's Technical Research Committee was incorporated into the work plan.

To meet the project's objectives, 24 houses were constructed in Winnipeg by Flair Homes Ltd. and independently monitored for periods of up to three years. Energy conservation levels ranged from those of conventional houses to those which met or exceeded the R-2000 Standard.

### 1.3 OBJECTIVE

This report was prepared to document, on a consistent, comparative basis, the incremental costs of the various energy conservation components and systems employed in the Flair Homes Energy Demo/CHBA Flair Mark XIV Project.

## SECTION 2

## REVIEW OF PREVIOUS COSTING STUDIES

### 2.1 PREVIOUS STUDIES

Several previous studies have addressed the issue of incremental costs of residential energy conservation components and systems. Although none contained data which had direct application to the analysis described herein, several provided useful background information and offered insights into the development of a methodology for estimating incremental costs. Four of the studies which had particular relevance were:

"Incremental Construction Cost Analysis of R-2000 Homes Built in 1983", (Draft), (M. Lubun & Associates 1986). This documented the incremental energy conservation costs of 266 R-2000 houses constructed in 1983. The cost data was obtained from reports submitted by the builder after the house had been completed.

"Cost Effectiveness Study of R-2000 Homes Built in 1983", (Draft), (M. Lubun & Associates 1986). This study used the results of the previous reference to derive average cost figures which were in turn applied using a discounted payback analysis to assess the cost effectiveness of the various conservation options.

"Incremental Cost Analysis of R-2000 Homes", (Bureau of Management Consulting 1986). This report summarized a study conducted in late 1986 in which 22 R-2000 builders from across Canada were interviewed to determine their incremental costs to build two standard houses to the R-2000 energy target versus their conventional style of construction and the 1983 "Measures for Energy Conservation".

"The True Cost of Energy Conservation", (Progressive Builder 1986). A study which looked at the incremental costs in the U.S. Pacific Northwest, this investigation provided some useful background information, particularly since it was aimed at a builder audience.

### 2.2 REVIEW

A review of the four background studies was conducted and the following observations and general conclusions were made:

1. Wide variations in the reported costs suggested that the builder's personal experience with the systems may have had an undue influence in their assessment of the incremental costs. For example, Lubun (1986) asked builders to estimate the cost of improving the airtightness of a standard, pre-defined house design. They responded with a range of

$156 to $1050 for a simple bungalow and $0 to $2075 for a 2 storey design. It seems unlikely that such extreme variations accurately reflect the true costs, particularly once the initial learning period with a new system has been passed. Thus, for this study the decision was made to assume that the builder was experienced with each of the systems and could build or install them with normal production efficiency.

2. Incremental construction costs are difficult to assess with the same confidence of, for example, energy consumption. A construction site is a dynamic environment and unlike that of a factory, it is often hard to assess the cost of a small design change. In particular, labour costs are often difficult to determine when changes affect more than one subtrade.

3. The inclusion of "overhead and profit" costs tends to confuse reported results since builders have different opinions as to what to include. Administration, taxes, rent, supervision, insurance, interest charges, training, etc. can all potentially be included and to widely varying degrees. Thus for this study, overhead and profit were not included in the determination of the estimated incremental costs. The reader is advised to include, if desired, appropriate values based on personal or local experience.

4. Most houses, including those constructed by R-2000 builders, are not optimized with respect to the R-2000 energy target or other energy standards. Total package costs (as opposed to component costs) often include unnecessary expenses due to over-design.

5. Finally, it must be admitted that the "complete" cost study will never exist. Cost differences caused by variations in house design, local material and labour charges, inflation, quality of construction, size of business, experience, and market preferences will make any study incomplete and, in time, dated.

## SECTION 3

## DEVELOPMENT OF THE COST DATA

### 3.1 PROCEDURE

Following the review of the background studies, a procedure was developed for analyzing and reporting the cost data generated during the Flair project. After construction of the 24 project houses, a list was assembled of the various energy conservation systems which, it was felt, could be costed with reasonable confidence because they had either been used in the houses or were supplied by a single subtrade willing to provide cost data.

Incremental costs were developed and reported on a component and system basis. A system was defined as a single conservation measure applicable to one part of the house. Typical systems included: an upgraded wall, underslab insulation and a high efficiency heating system. Each system was analyzed by breaking it down into component steps which described the additional and (any) deleted material and labour requirements relative to conventional practice. For example, a main wall system with used 38x140 (2x6) framing with 25 mm (1") of exterior, insulated sheathing required: additional studs, corner bracing, insulated sheathing, tape and longer fasteners. However, the system eliminated the need for conventional fibreboard sheathing and building paper.

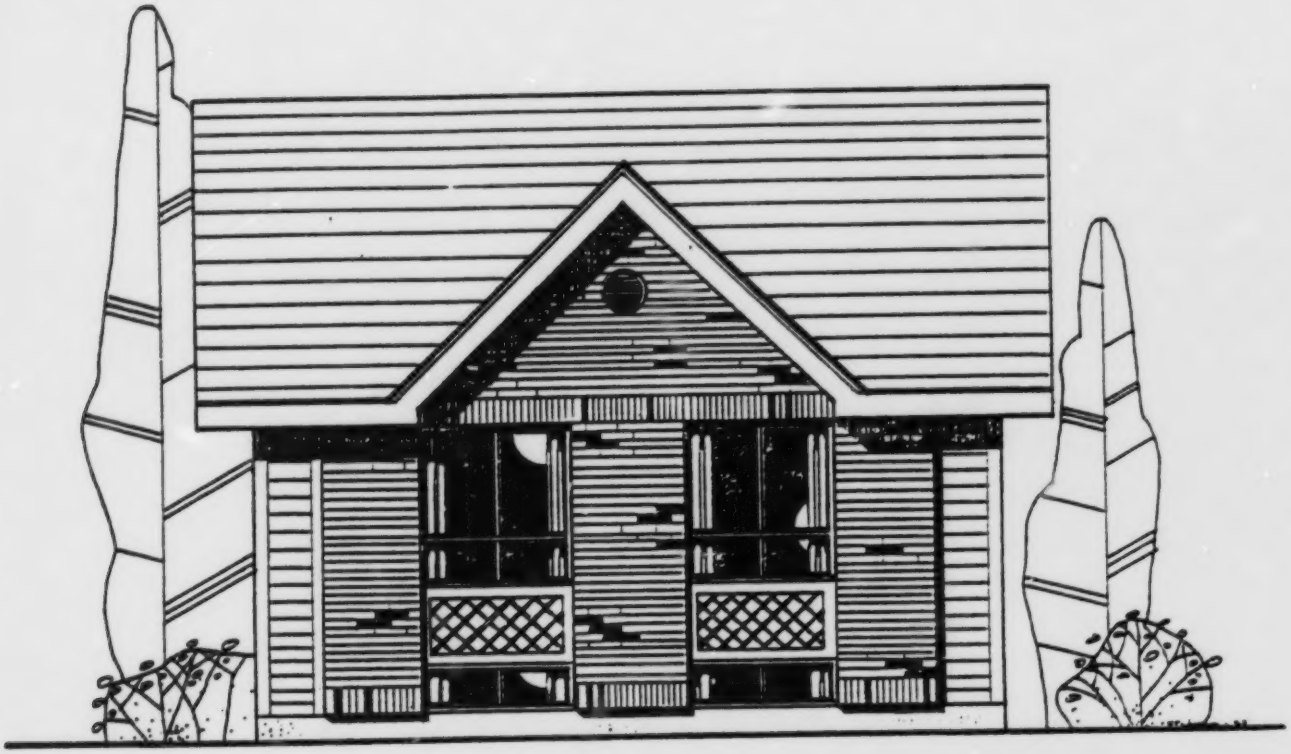
Material and component costs were estimated using supplier prices with appropriate allowances for wastage. Labour costs were provided by the builder and sub-trades. One of the project houses, #12, was then selected as a reference structure and each of the systems costed with respect to it. A floor plan and front elevation are shown in Fig. 1.

### 3.2 BASIC ASSUMPTIONS

To provide a consistent basis for analysis of the various components and systems used in the development of the incremental costs, the following assumptions were made:

Builder Profile - The components and systems were assumed to have been built or installed by Flair Homes (Manitoba) Ltd., a large tract builder which produced 500 to 600 houses per year in the Winnipeg market. Their size of operation provided them with good purchasing power for goods and services. Flair began marketing energy efficient houses in 1980 and were the first tract builder in Canada to offer a well-sealed, double wall house as an option. All work was supplied by subtrades with the builder responsible for site supervision.

Experience and Productivity - Costs were calculated assuming that subtrades and supervisors were experienced in applying the components and systems on a



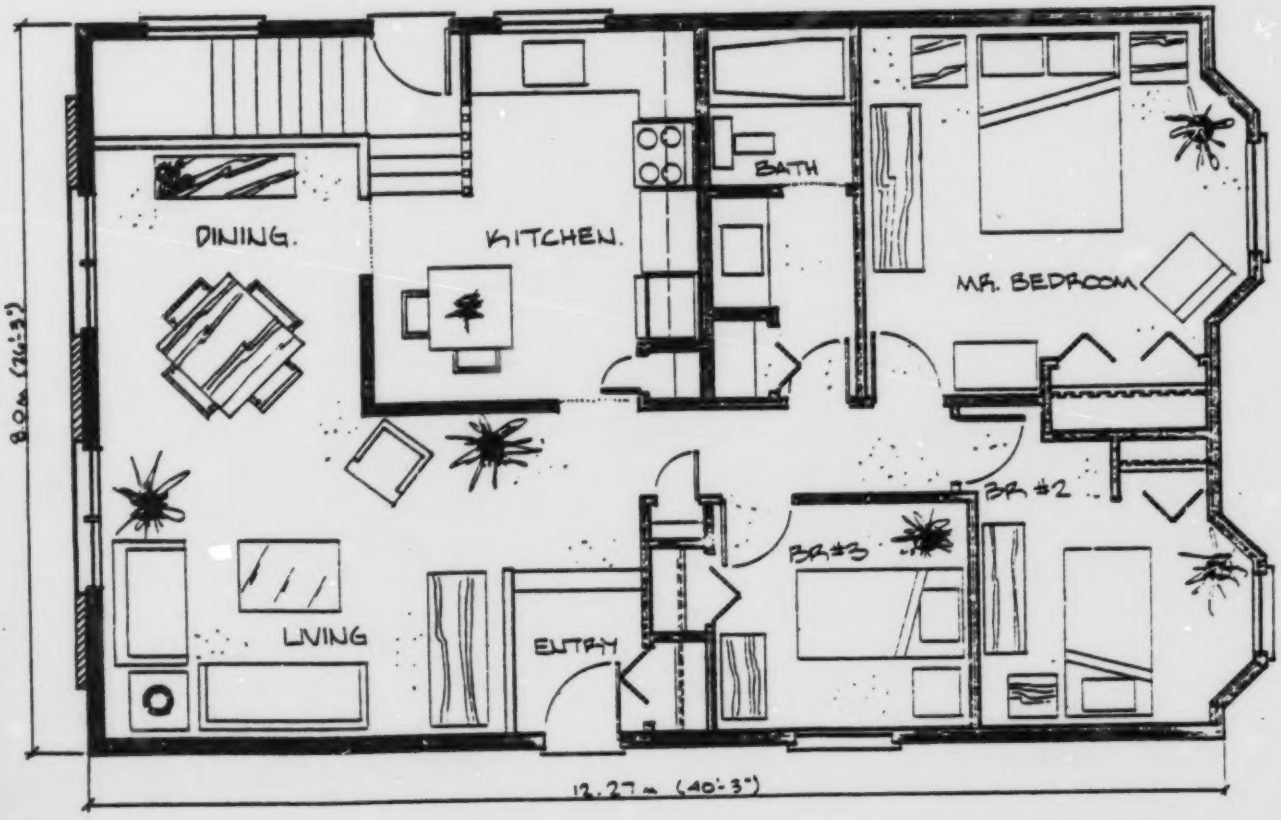

DINING.
KITCHEN.
BATH
MR. BEDROOM
BR #2
BR #3
LIVING
ENTRY
8.0m (26'-3")
12.27m (40'-3")

FIGURE 1

production basis. Normal tract builder productivity levels were assumed.

House Type - The components and systems were costed using House #12 as a reference structure. This was a 97 m² (1040 ft²) bungalow with a full-depth, cast-in-place concrete basement).

House Location - Winnipeg

Material and Equipment Costs - Material costs were provided by Flair's regular suppliers, with costs effective as of the spring of 1987. Costs for windows and some of the mechanical equipment were quoted in August 1990 dollars. Material, equipment and labour rates were tabulated using data from 1987 and 1990. No adjustment was made for inflation because examination of data for new house costs in the Winnipeg market showed only a small change (less than 2%) between June 1987 and March 1990, the most recent month for which data was available (Statistics Canada 1990). Material costs were defined as the supplier-invoiced costs to the builder. A few examples are given in Table 1.

Labour costs - Labour costs were estimated in consultation with the builder's Site Supervisor and subtrades. In instances where subtrades bid on a task basis, estimated labour rates were used.

Provincial Sales Tax - None included.

Goods and Services Tax - None include.

Overhead and Profit - None included.

In summary, the incremental system costs discussed in this report were calculated for a 97 m² (1040 ft²) bungalow constructed in Winnipeg by a tract builder using experienced and efficient subtrades and supervisors with minimal disruption between subtrades. Incremental component and system costs were defined as those which the builder would pay, with no provision for builder overhead or profit. Retail costs may be calculated by adding overhead and profit to these figures. Data from this report can be applied to other house types and sizes, locations, builders, etc. provided the necessary modifications are made.

## TABLE 1

## SAMPLE MATERIAL COSTS AND LABOUR RATES

| | |
|---|---|
| MATERIALS | |
| 38x140 (2x6) #2 or better kiln-dried spruce | $348.00/1000 board feet |
| 16 mm (5/8") fibreboard sheathing | $2.84/m² (26.4 ¢/ft²) |
| Batt insulation | $1.22 m²•RSI (2 ¢/ft²•R) |
| 51 mm (2") Baseclad insulated sheathing | $7.51/m² (69.8 ¢/ft²) |
| 51 mm (2") SM insulated sheathing | $9.29/m² (86.3 ¢/ft²) |
| 6 mil polyethylene | 26.4 ¢/m² (2.45 ¢/ft²) |
| Acoustical sealant (900 ml tube) | $4.98/tube |
| LABOUR RATES | |
| Framers | $15.00/hour |
| Drywallers/insulators | $12.00/hour |
| Painters | $15.00/hour |
| Electricians | $17.50/hour |
| Sheet metal installers | $15.00/hour |

## 3.3 COMPONENT AND SYSTEM DATA SHEETS

Each conservation component and system analyzed is summarized on a separate Data Sheet, contained in Appendix A, that provides the following information:

Gross Cost - The total estimated incremental cost for the additional steps required to build or install the component or system.

Savings - The savings resulting from any deleted steps.

Net Cost - The estimated incremental cost to the builder of the component or system relative to conventional practice (i.e. Gross Cost minus Savings).

Net Unit Incremental Cost (NUIC) - The Net Cost divided by the area of the component which was upgraded (building envelope components only).

Cost Performance Index (CPI) - A benefit/cost parameter used to express and rank the cost effectiveness of envelope systems relative to conventional practice, as described below.

## 3.4 COST PERFORMANCE INDEX

The CPI (Cost Performance Index) is a benefit/cost parameter developed for this study which describes the cost effectiveness of insulation component and systems. The larger the CPI, the greater the cost effectiveness. It is not applicable to airtightness or mechanical systems. The "benefit" from adding insulation beyond that normally used in conventional design can be express as . . .

$$K\left[\frac{1}{RSI_{conv.}} - \frac{1}{RSI_{upgraded}}\right] \qquad (1)$$

where "K" is a constant which accounts for the component area, climate, fuel cost and heating plant efficiency. For a given house in a specified location, K will not change and can be removed from the definition since the CPI is intended as a comparative indicator with no physical significance. Values for the thermal resistance of envelope components were calculated using nominal RSI-values for consistency with the practice used by the R-2000 Program.

The "cost" of the component or system is the Net Unit Incremental Cost, as defined in this study. For convenience, the dividend shown in Eq.1 was multiplied by 1000. Thus the CPI is defined as . . .

$$CPI = \frac{1000\left[\frac{1}{RSI_{conv.}} - \frac{1}{RSI_{upgraded}}\right]}{NUIC} \qquad (2)$$

Example: Calculate the CPI of upgrading a conventional 38x89 (2x4) wall to a 38x140 (2x6) wall @ 400 mm (16") with 51 mm (2") of extruded polystyrene sheathing.

From the System Data Sheet for W-2 (I), the NUIC is $14.96 per square meter and the nominal RSI values for the conventional and upgraded walls are 2.11 and 5.28 respectively. Thus the CPI is . . .

$$= \frac{1000\left[\frac{1}{2.11} - \frac{1}{5.28}\right]}{14.96}$$

$$= 19$$

Comparisons of CPI values for different envelope components should be restricted to those with the same heat transfer characteristics. Thus, CPI values for above grade walls and ceilings can be compared directly while values for basement walls can only be compared to those of other basement walls since below-grade heat losses are affected by the surrounding soil (which is not accounted for by the CPI). Similarly, CPI values for basement slab insulation systems should only be compared to other slab insulation systems.

### 3.5 CONTROLLING THE COST OF DESIGN CHANGES

All costs were calculated assuming ideal circumstances to provide a better assessment of the capabilities of each component or system. No allowances were made for learning time, errors, design changes or any of the many other inevitable factors which crop up when a new feature is first tried. Therefore, it is worthwhile to add a few notes on controlling the cost of design changes.

#### 3.5.1 The Cost of Learning

The time required to learn how to build or install a new component or system will obviously vary with the complexity of the system, worker experience and the magnitude of the changes from conventional practice. To provide an example of the "learning curve", the head framer responsible for several of the project houses estimated the additional time to incorporate a new framing system beyond the normal production time as...

First house - 25% to 35%
Second house - 10% to 20%
Third house - approaching zero

Thus, if a new system (once fully learned) required an additional 10 hours more than conventional practice, the first house would require 12.5 to 13.5 hours to incorporate the system while the second house would require 11 to 12 hours.

### 3.5.2. The Cost of Change

"Change" is in itself an added cost. This study estimated incremental costs for a number of energy conservation components and systems on the assumption of high worker productivity with insignificant learning time requirements. Tract builders typically operate in this manner provided no substantial changes are made from house to house. Changes which are incorporated often prove difficult and expensive to implement because of the scale of operation and the degree of specialization. Changes have to be transmitted from the design office to the Area Manager to the Site Supervisor to the appropriate subtrade(s) and suppliers and then subsequently inspected by the Site Supervisor to verify compliance. One comment was ruefully made that the effect of eliminating a single minor component (say the building paper on exterior walls) would increase the construction cost since the additional time to transmit the change and supervise its implementation would cost more than the savings resulting from the reduced labour and material requirements. For a tract builder, the most efficient manner in which to operate is to minimize the variations from house to house. Once a "package" has been designed (incorporating any number of systems), it is desirable to maintain it as constant as possible.

The situation is somewhat different for custom builders. Since the Designer, Area Manager and Site Supervisor may well be the same individual and fewer crews are used for a given subtrade, changes can be implemented somewhat easier.

Changes represent major disruptions to the normal process of designing and building a house. In particular, major costs can result if significant re-scheduling between subtrades is required (which drives up both direct and overhead costs or if significant changes from normal material orders are required (which may result in mistakes and higher overhead cost).

### 3.5.3 The Cost of Maintaining Efficiency

Another factor found to impact costs was the availability of experienced subtrades able to maintain their proficiency with a new component or system. Once the new feature has been built or installed on a number of occasions, the subtrade should be able to incorporate it on a production basis, that is, at minimal incremental cost. Unfortunately, the component or system may be offered as an option and only occasionally selected by homebuyers. As a result the subtrade may have few opportunities to "build" it and therefore may be constantly relearning the process. Conversely, larger subtrade firms may use one or two experienced crews for all orders rather than employ them in (for example) the one subdivision in which they normally work thereby reducing efficiency. This is particularly relevant for some mechanical components, such as integrated systems, which require specially trained installers.

## SECTION 4

## WALLS

### 4.1 CONVENTIONAL PRACTICE

Two types of exterior wall construction are commonly used for detached and semi-detached housing in Canada. In the east and on the west coast, 38x89 (2x4) framing with RSI 2.11 (R-12) insulation is the most common system while in Manitoba, Saskatchewan, Alberta and the north, 38x140 (2x6) construction with RSI 3.52 (R-20) insulation has become the norm over the last decade.

### 4.2 SYSTEM OPTIONS ANALYZED

Four types of wall systems, with several subtypes, were studied. These are summarized along with their NUIC and CPI values in Table 2. System W-1 is the 38x140 (2x6) frame wall while systems W-2(a) to W-2(o) use rigid glass fibre insulated sheathing (Fibreglas Canada "Glasclad") or extruded polystyrene sheathing (Dow "SM"), with 400 mm (16") or 600 mm (24") stud spacing and 38x89 (2x4) or 38x140 (2x6) studs. System W-3 is a frame wall with interior strapping (in four versions) and System W-4 represents double wall construction.

### 4.3 CHANGES FROM CONVENTIONAL PRACTICE

Each of the upgraded wall systems was compared to both 38x89 (2x4) and 38x140 (2x6) construction. The list of required changes for each conventional system is summarized on its data sheet.

#### 4.3.1 38x140 (2x6) Frame Walls

The 38x89 (2x4) studs were replaced with 38x140 (2x6) studs, the RSI 2.11 (R-12) glass fibre batts were replaced with RSI 3.52 (R-20) batts and jamb extensions were added to the doors and windows.

#### 4.3.2 Frame Walls with Exterior Insulated Sheathing

The major change required for this system was the use of insulated sheathing, generally in place of the conventional structural sheathing. To provide the necessary lateral support to the wall, corner bracing was also added. Framing at corners was built-out to provide a solid nailing base for the exterior cladding or stucco, and the rough openings for doors and windows were built-out to permit secure fastening. If Glasclad sheathing was used, the stud spacing was reduced to 400 mm (16") O.C or a rigid exterior cladding employed. Taping of the exterior spun-bonded polyolefin ("Tyvek") air barrier at joints between sheets and around penetrations was also included; Tyvek also permitted the building paper to be eliminated. When the Glasclad was used in a reversed configuration, the tape was eliminated since the joints occurred over framing members), although the building paper had to be retained under the stucco or siding. Since Glasclad is relatively flexible, an allowance had to be added for extra material and labour for the stucco

## TABLE 2
## WALL SYSTEMS

| SYSTEM | NOMINAL THERMAL RESISTANCE (RSI) | (R) | CONVENTIONAL: 38x89 (2x4) NUIC ($/m²) | ($/ft²) | CPI | CONVENTIONAL: 38x140 (2x6) NUIC ($/m²) | ($/ft²) | CPI |
|---|---|---|---|---|---|---|---|---|
| W-1 38x140 (2x6) @ 600 mm (24") with 16 mm (5/8") fibreboard sheathing | 3.52 | 20.0 | 4.01 | 0.37 | 47 | | | |
| W-2(a) 38x140 (2x6) @ 400 mm (16") with 25 mm (1") exterior Glasclad insulated sheathing c/w taped Tyvek air retarder, corner bracing | 4.30 | 24.4 | 8.39 | 0.78 | 29 | 4.73 | 0.44 | 11 |
| W-2(b) 38x140 (2x6) @ 400 mm (16") with 38 mm (1 1/2") exterior Glasclad insulated sheathing c/w taped Tyvek air retarder, corner bracing | 4.70 | 26.7 | 11.62 | 1.08 | 22 | 7.96 | 0.74 | 9 |
| W-2(c) 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior Glasclad insulated sheathing c/w taped Tyvek air retarder, corner bracing | 5.07 | 28.8 | 13.88 | 1.29 | 20 | 10.22 | 0.95 | 8 |
| W-2(d) 38x140 (2x6) @ 400 mm (16") with 25 mm (1") exterior Glasclad insulated sheathing c/w Tyvek air retarder (reversed, joints not taped), corner bracing | 4.30 | 24.4 | 7.75 | 0.72 | 31 | 4.09 | 0.38 | 13 |
| W-2(e) 38x140 (2x6) @ 400 mm (16") with 38 mm (1 1/2")exterior Glasclad insulated sheathing c/w Tyvek air retarder (reversed, joints not taped), corner bracing | 4.70 | 26.7 | 11.19 | 1.04 | 23 | 7.42 | 0.69 | 10 |
| W-2(f) 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior Glasclad insulated sheathing c/w Tyvek air retarder (reversed, joints not taped) | 5.07 | 28.8 | 13.45 | 1.25 | 21 | 9.79 | 0.91 | 9 |
| W-2(g) 38x89 (2x4) @ 400 mm (16") with 38 mm (1 1/2)exterior SM insulated sheathing, corner bracing | 3.43 | 19.5 | 8.39 | 0.78 | 22 | 4.73 | 0.44 | -2 |
| W-2(h) 38x89 (2x4) @ 400 mm (16") with 51 mm (2") exterior SM insulated sheathing, corner bracing | 3.87 | 22.0 | 10.65 | 0.99 | 20 | 6.89 | 0.64 | 4 |

**TABLE 2 (con't)**

| SYSTEM | | NOMINAL THERMAL RESISTANCE (RSI) | (R) | CONVENTIONAL: 38X89 (2X4) NUIC ($/m²) | ($/ft²) | CPI | CONVENTIONAL: 38x140 (2x6) NUIC ($/m²) | ($/ft²) | CPI |
|---|---|---|---|---|---|---|---|---|---|
| W-2(i) | 38X89 (2X4) @ 600 mm (24") with 38 mm (1 1/2") exterior SM insulated sheathing, corner bracing | 3.43 | 19.5 | 7.42 | 0.69 | 25 | 3.77 | 0.35 | -2 |
| W-2(j) | 38x89 (2x4) @ 600 mm (24") with 51 mm (2") exterior SM insulated sheathing, corner bracing | 3.87 | 22.0 | 9.68 | 0.90 | 22 | 5.92 | 0.55 | 4 |
| W-2(k) | 38x140 (2x6) @ 400 mm (16") with 38 mm (1 1/2") exterior SM insulated sheathing, corner bracing | 4.84 | 27.5 | 12.16 | 1.13 | 22 | 8.50 | 0.79 | 9 |
| W-2(l) | 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior SM insulated sheathing, corner bracing | 5.28 | 30.0 | 14.96 | 1.39 | 19 | 11.19 | 1.04 | 8 |
| W-2(m) | 38x140 (2x6) @ 600 mm (24") with 38 mm (1 1/2") exterior SM insulated sheathing, corner bracing | 4.84 | 27.5 | 10.65 | 0.99 | 25 | 6.99 | 0.65 | 11 |
| W-2(n) | 38x140 (2x6) @ 600 mm (24") with 51 mm (2") exterior SM insulated sheathing, corner bracing | 5.28 | 30.0 | 13.45 | 1.25 | 21 | 9.79 | 0.91 | 10 |
| W-2(o) | 38x89 (2x4) @ 400 mm (16") with 51 mm (2") exterior SM insulated sheathing, fibreboard sheathing | 3.87 | 22.0 | 13.77 | 1.28 | 16 | 10.11 | 0.94 | 3 |
| W-3(a) | 38x89 (2x4) @ 600 mm (24") with 38x38 (2x2) interior strapping | 2.99 | 17.0 | 6.99 | 0.65 | 20 | 2.31 | 0.21 | -22 |
| W-3(b) | 38x89 (2x4) @ 600 mm (24") with 38x64 (2x3) interior strapping | 3.70 | 21.0 | 8.95 | 0.83 | 23 | 4.27 | 0.40 | 3 |
| W-3(c) | 38x140 (2x6) @ 600 mm (24") with 38x38 (2x2) interior strapping | 4.40 | 25.0 | 11.67 | 1.08 | 21 | 6.99 | 0.65 | 8 |
| W-3(d) | 38x140 (2x6) @ 600 mm (24") with 38x64 (2x3) interior strapping | 5.11 | 29.0 | 13.63 | 1.27 | 20 | 8.95 | 0.83 | 10 |
| W-4 | Double wall | 7.04 | 40.0 | 38.52 | 3.58 | 9 | 34.54 | 3.21 | 4 |

NOTES:
1. NUIC = Net Unit Incremental Cost per unit wall area
2. CPI = Cost Performance Index

scratch coat. If SM sheathing was used, either 400 mm (16") or 600 mm (24") stud spacing could be used. Building paper was still required to meet code requirements. With either type of insulated sheathing, door and window jamb extensions or exterior returns were required. Interior drywall returns could also be used although these were not costed. In some cases, gable end roof trusses had to be cantilevered to provide a continuous vertical surface for the exterior cladding.

#### 4.3.3 Frame Walls With Interior Strapping

Horizontal strapping and insulation were installed and jamb extensions added to doors and windows. If the upgrade included a switch from 38x89 (2x4) to 38x140 (2x6) framing, wider framing members, thicker insulation batts and an additional 51 mm (2") for the jamb extensions was also needed. The use of interior strapping was assumed to have a negligible effect on the cost of installing the air/vapour barrier, although the airtightness performance might be superior.

#### 4.3.4 Double Walls

Double wall construction represented the most radical departure from conventional practice since it required two complete walls to be framed and spaced apart using top and bottom plywood plates. All cavity spaces were filled with batt insulation and the air/vapour barrier was made an integral part of the wall. Returns were used for all doors and windows. Due to the thickness of the finished wall, the exterior dimensions of the house were extended by 300 mm (12") in each direction to prevent excessive loss of interior floor area. This necessitated additional material for the foundation, floor system, roof and exterior cladding.

### 4.4 INCREMENTAL COSTS

The incremental costs, expressed as the NUIC per net unit area of interior wall (i.e. exclusive of door and window areas) are shown in Table 2 and Figs. 2 and 3.

#### 4.4.1 Conventional: 38x89 (2x4) Walls

The incremental cost of upgrading to a 38x140 (2x6) wall was $4.01/m² ($0.37/ft²) (W-1), which represented the least expensive option in this category. The frame wall with exterior insulated sheathing had incremental costs ranging from $7.42/m² to $14.96/m² ($0.69/ft² to $1.39/ft²) while the strapped wall ranged from $6.99/m² to $13.63/m² ($0.65/ft² to $1.27/ft²). The incremental cost of the double wall was estimated at $38.52/m² ($3.58/ft²).

#### 4.4.2 Conventional: 38x140 (2x6) Walls

The incremental cost of upgrading a 38x140 (2x6) wall to the equivalent wall with exterior insulated sheathing ranged from $3.77/m² to $11.19/m² ($0.35/ft² to $1.04/ft²) while the interior strapped walls ranged from $2.31/m² to $8.95/m² ($0.21/ft² to $0.83/ft²). The incremental cost for the double wall was

FIGURE 2

WALL NUIC VALUES
CONVENTIONAL PRACTICE 38x89 (2x4)

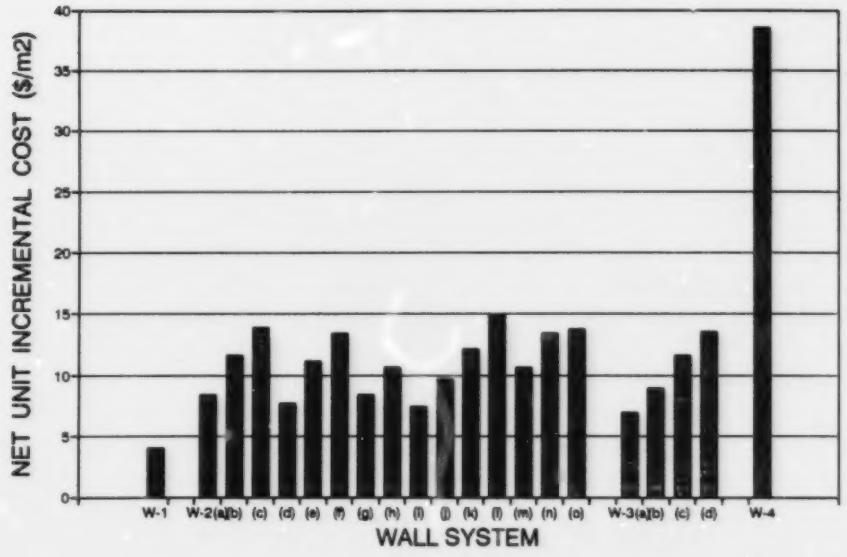
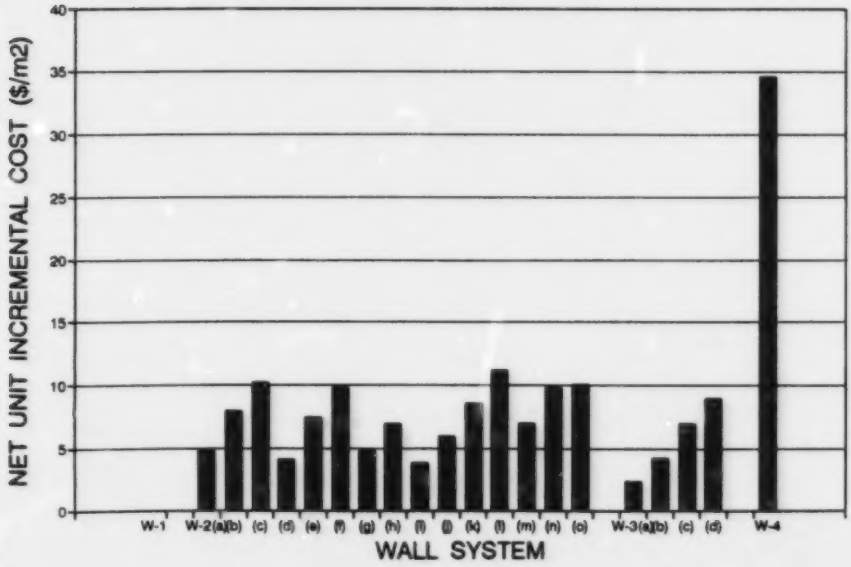



FIGURE 3

WALL NUIC VALUES
CONVENTIONAL PRACTICE 38x140 (2x6)



$34.54/m² ($3.21/ft²).

## 4.5 COST PERFORMANCE INDEX

### 4.5.1 Conventional: 38x89 (2x4) Walls

The CPI reached a maximum of 47 for the case of upgrading a 38x89 (2x4) wall to 38x140 (2x6) construction as shown in Table 2 and Figs. 4 and 5. For single stud walls with exterior insulated sheathing, the index was somewhat lower, ranging from 16 to 29 while the values for interior strapped walls were relatively consistent ranging from 20 to 23. The CPI for the double wall CPI was 9, a comparatively low value.

### 4.5.2 Conventional: 38x140 (2x6) Walls

As expected, CPI values for upgrading from 38x140 (2x6) construction were much lower, varying from -2 to 13 for walls with exterior insulated sheathing to -22 to 10 for interior strapped walls. Negative CPI values indicate that the "upgraded" thermal performance of the wall was poorer than the conventional system. (Obviously these systems make no economic sense.) The CPI for double wall construction was 4.

## 4.6 OBSERVATIONS

1. The highest Cost Performance Index was achieved by upgrading a 38x89 (2x4) wall to 38x140 (2x6) construction. Although not surprising, the fact that the CPI was approaching twice that of the next highest system should be noted.

2. The incremental costs (NUIC) and the cost effectiveness (CPI) of upgrading from conventional 38x89 (2x4) and 38x140 (2x6) frame walls to walls with either exterior insulated sheathing or interior strapping were generally similar.

3. Since the two systems have a similar cost effectiveness, the choice between walls with exterior insulated sheathing and strapped walls is best made on the basis of other factors. For example, strapped wall construction reduces the useful interior floor area (unless the dimensions of the house are increased which would significantly increase the overall cost), while exterior insulated sheathing systems may increase property taxes since these are based on exterior dimensions.

4. The CPI values for the double wall were low relative to the other systems, indicative of the significant labour and materials required to construct the system.

5. A major cost for many of the wall systems was the jamb extensions for doors and windows required to accommodate the extra wall thickness.

FIGURE 4

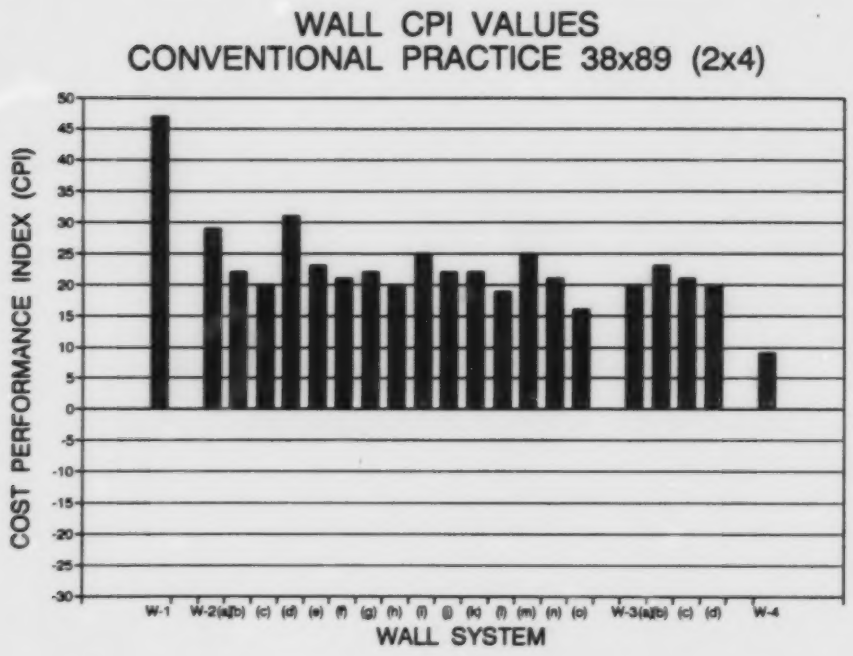
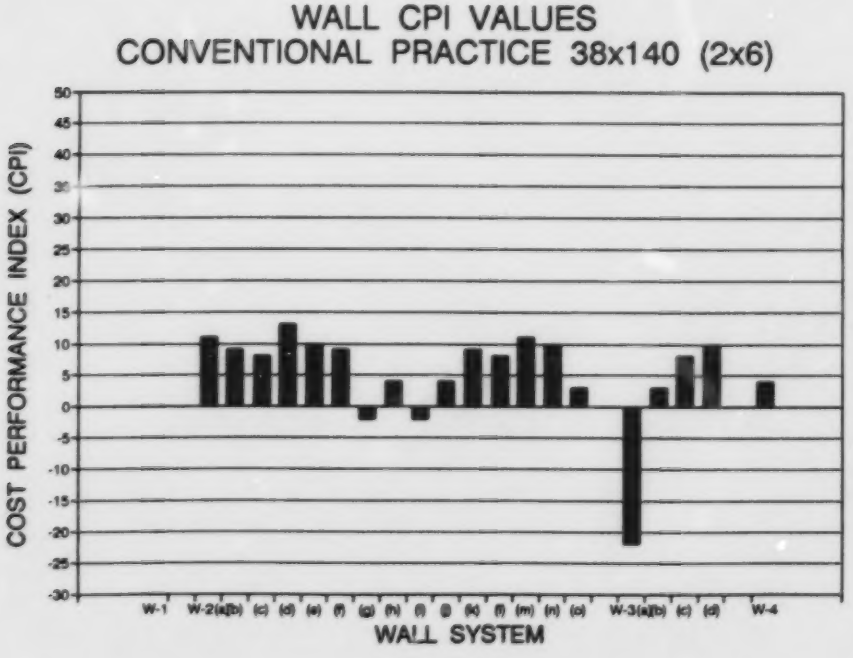



FIGURE 5



This might be reduced using drywall returns or other alternatives.

6. Based on the analysis of the four wall systems investigated, the following recommendations can be made: the most cost-effective upgrade from conventional 38x89 (2x4) construction is to switch to standard 38x140 (2x6) framing. The most cost-effective upgrade from 38x140 (2x6) construction is to use either a wall with exterior insulated sheathing or an interior strapped wall, with the final choice being made on the basis of other factors.

## SECTION 5

## BASEMENTS

### 5.1 CONVENTIONAL PRACTICE

The most common basement insulation system consists of interior glass fibre batts in 38x64 (2x3) or 38x89 (2x4) framing. For this study, conventional practice was assumed to be RSI 1.76 (R-10) insulation extending from the floor slab to the underside of the floor joists. The floor slab was assumed to be uninsulated.

### 5.2 SYSTEM OPTIONS ANALYZED

Thirteen basement systems (10 basement wall and 3 floor slab) were studied, as shown in Table 3.

### 5.3 CHANGES FROM CONVENTIONAL PRACTICE

#### 5.3.1. Basement Walls

Systems B-1 to B-3 were basic upgrades from conventional practice with extra insulation added to the interior basement walls. Systems B-4 to B-8 used exterior insulation schemes which required a pressure-treated nailer to be cast into the foundation at grade level to serve as a nailing base or an equivalent mechanical fastening system be used. Door and window rough-openings also had to be roughed out to provide a solid nailing base. The exterior systems were assumed to extend to the footing level with the sheets oriented vertically. Both rigid glass fibre (Fibreglas Canada "Baseclad") and extruded polystyrene (Dow "SM") were considered. The insulation was covered or parged for protection and the interior framing, insulation and polyethylene as well as the dampproofing were omitted. Systems B-9 and B-10 were combinations of interior and exterior insulation.

#### 5.3.2 Floor Slab

The underslab insulation systems, B-11 and B-12, required 25 mm (1") of rigid or semi-rigid insulation to be installed on top of the aggregate prior to the slab being poured. System B-13 was a measure designed to control floor slab cracking using cast-in-place crack initiators.

### 5.4 INCREMENTAL COSTS

A summary of each system's NUIC and CPI values, expressed per square metre of wall or slab area (using interior dimensions), is given in Fig. 6.

#### 5.4.1 Basement Walls

Incremental costs ranged from \$0.43/m² to \$16.99/m² (\$0.04/ft² to \$1.58/ft²). The lower values were for basic upgrades of thicker interior insulation and the higher values represented the exterior systems.

## TABLE 3
## BASEMENT SYSTEMS

| SYSTEM | NOMINAL THERMAL RESISTANCE | | NET UNIT INCREMENTAL COST | | COST PERFORMANCE INDEX |
|---|---|---|---|---|---|
| | RSI | R | $/m² | $/ft² | |
| B-1 RSI 2.11 (R-12.0) interior G/F batts, 38x64 (2x3) framing | 2.11 | 12.0 | 0.43 | 0.04 | 219 |
| B-2 RSI 3.52 (R-20.0) interior G/F batts, 38x64 (2x3) framing | 3.52 | 20.0 | 2.29 | 0.21 | 124 |
| B-3 RSI 4.23 (R-24.0) interior G/F batts, 38x64 (2x3) framing | 4.23 | 24.0 | 3.43 | 0.32 | 97 |
| B-4 51mm (2") exterior Basecląd insulation, interior unfinished | 1.50 | 8.5 | 8.98 | 0.83 | -11 |
| B-5 76mm (3") exterior Basecląd insulation, interior unfinished | 2.38 | 13.5 | 12.90 | 1.20 | 11 |
| B-6 51mm (2") exterior SM insulation, interior unfinished | 1.76 | 10.0 | 10.19 | 0.95 | 0 |
| B-7 76mm (3") exterior SM insulation, interior unfinished | 2.64 | 15.0 | 15.45 | 1.44 | 12 |
| B-8 102mm (4") exterior SM insulation, interior unfinished | 3.52 | 20.0 | 16.99 | 1.58 | 17 |
| B-9 RSI 1.76 (R-10.0) interior G/F batts, 51mm (2") exterior Basecląd insulation | 3.26 | 18.5 | 14.00 | 1.30 | 19 |
| B-10 RSI 1.76 (R-10.0) interior G/F batts, 51mm (2") exterior SM insulation | 3.52 | 20.0 | 15.21 | 1.41 | 19 |
| B-11 Slab; 25mm (1") Glascląd insulation under slab | 0.97 | 5.5 | 4.69 | 0.44 | 881 |
| B-12 Slab; 25mm (1") SM under slab | 1.07 | 6.1 | 5.55 | 0.52 | 762 |
| B-13 Slab; crack initiators and isolators | N/A | N/A | 0.84 | 0.08 | N/A |

NOTES:
1. NUIC values per unit of component area
2. G/F = glass fibre

FIGURE 6

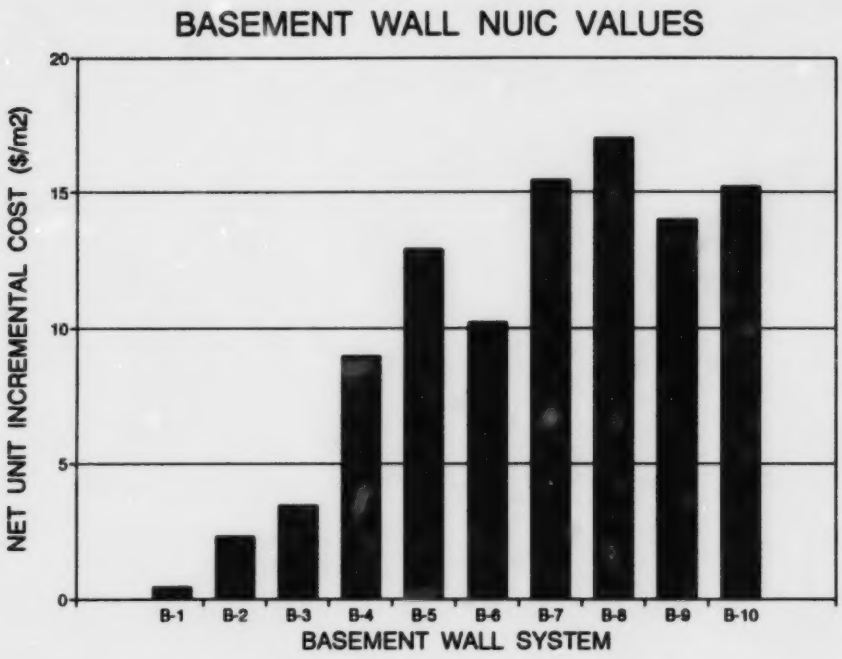
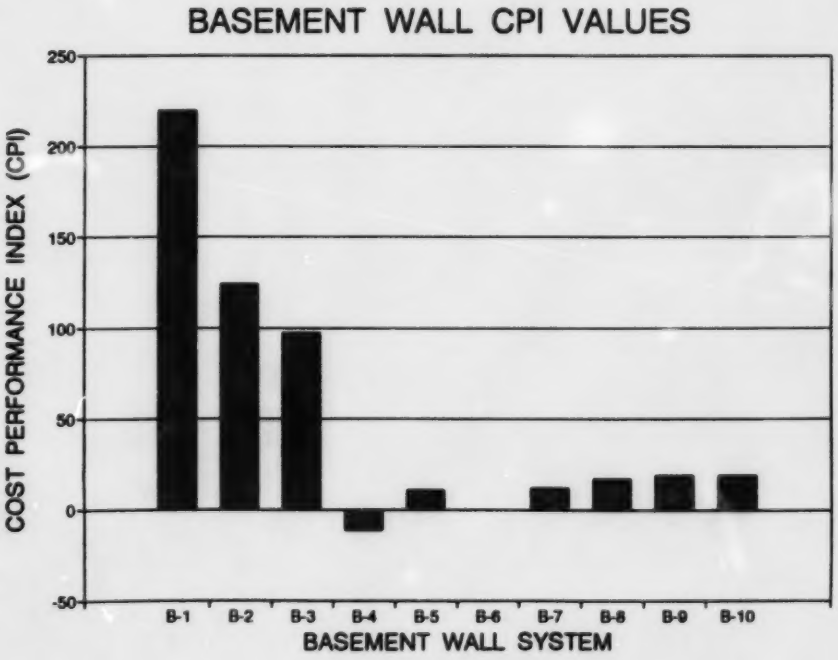



FIGURE 7



### 5.4.2 Floor Slab

The two underslab insulation systems cost $4.69/m² and $5.55/m² ($0.44/ft² and $0.52/ft²) respectively while the slab crack control measures averaged $0.84/m² ($0.08/ft²).

## 5.5 COST PERFORMANCE INDEX

### 5.5.1 Basement Walls

The high CPI values for the interior schemes reflect the minor cost of upgrading from conventional practice and the relatively low RSI value of the conventional system, RSI 1.76 (R-10), see Fig. 7. In contrast, the exterior and combined exterior/interior schemes had much lower CPI values.

### 5.5.2 Floor Slab

The high indices for the two underslab systems are noted although recall that the effects of the soil are ignored and thus only the RSI value of the concrete and air film contributed to the original RSI value which inflated the calculated indices.

## 5.6 OBSERVATIONS

1. Interior basement wall insulation systems displayed high Cost Performance Index values indicating these systems should be give high priority when upgrading the thermal integrity of basements.

2. The most cost-effective applications of exterior insulation were those systems which used the maximum insulation thickness available. This occurred because the fixed cost of installing the insulation represented a significant percentage of the total cost. The CPI values for the two types of exterior insulation were similar for equivalent material thicknesses.

3. Most of the added cost of the basement systems was due to the additional material requirements: insulation for the interior systems and the cladding, pressure-treated nailer and built-out rough openings for the exterior systems.

4. Although direct comparisons cannot be made between CPI values for sub-slab insulation and those of other envelope components, the high values suggest they be considered for upgrade packages.

## SECTION 6

## CEILINGS

### 6.1 CONVENTIONAL PRACTICE

The most common ceiling system uses a truss roof with blown-in insulation; cathedral ceilings are also popular. For this study, conventional practice was assumed to be a truss roof with RSI 7.04 (R-40) insulation. Conventional, non-raised-heel trusses were assumed. Incremental costs for the systems using cellulose fibre were calculated assuming cellulose fibre had been used in the conventional application. Likewise, glass fibre blowing wool was assumed for conventional practice for systems using glass fibre insulation.

### 6.2 SYSTEM OPTIONS ANALYZED

Eight ceiling systems were analyzed as shown in Table 4. These used the two types of insulation in incremental amounts ranging from RSI 7.93 (R-45) to RSI 10.57 (R-60).

### 6.3 CHANGES FROM CONVENTIONAL PRACTICE

Only the cost of the added insulation was assumed for the cost estimates with no provision for raised heel truss. This should be noted when reviewing ceiling system incremental costs since raised heel trusses, if used, would increase total costs.

### 6.4 INCREMENTAL COSTS

Incremental costs were quoted by the installer on the basis of area and insulation level for each type of material. These are summarized in Table 4 on the basis of the NUIC values using interior ceiling dimensions.

#### 6.4.1 Conventional: RSI 7.04 (R-40) Blown-In Cellulose

An installed cost of $\$0.824/m^2 \cdot RSI$ was quoted giving incremental costs ranging from $\$0.73/m^2$ to $\$2.91/m^2$ ($\$0.07/ft^2$ to $\$0.27/ft^2$) for Systems C-1 through C-4.

#### 6.4.2 Conventional: RSI 7.04 (R-40) Glass Fibre Blowing Wool

An installed cost of $\$0.974/m^2 \cdot RSI$ was quoted giving incremental costs of $\$0.86/m^2$ to $\$3.43/m^2$ ($\$0.08/ft^2$ to $\$0.32/ft^2$) for Systems C-5 through C-8.

### 6.5 COST PERFORMANCE INDEX

#### 6.5.1 Conventional: RSI 7.04 (R-40) Blown-in Cellulose

CPI values ranged from 16 to 22.

## TABLE 4
## CEILING SYSTEMS

| SYSTEM | NOMINAL THERMAL RESISTANCE | | NET UNIT INCREMENTAL COST | | COST PERFORMANCE INDEX |
|---|---|---|---|---|---|
| | RSI | R | $/m² | $/ft² | |
| C-1 RSI 7.93 (R-45.0) blown-in cellulose | 7.93 | 45.0 | 0.73 | 0.07 | 22 |
| C-2 RSI 8.81 (R-50.0) blown-in cellulose | 8.81 | 50.0 | 1.45 | 0.13 | 20 |
| C-3 RSI 9.69 (R-55.0) blown-in cellulose | 9.69 | 55.0 | 2.18 | 0.20 | 18 |
| C-4 RSI 10.57 (R-60.0) blown-in cellulose | 10.57 | 60.0 | 2.91 | 0.27 | 16 |
| C-5 RSI 7.93 (R-45.0) G/F blowing wool | 7.93 | 45.0 | 0.86 | 0.08 | 19 |
| C-6 RSI 8.81 (R-50.0) G/F blowing wool | 8.81 | 50.0 | 1.72 | 0.16 | 17 |
| C-7 RSI 9.69 (R-55.0) G/F blowing wool | 9.69 | 55.0 | 2.57 | 0.24 | 15 |
| C-8 RSI 10.57 (R-60.0) G/F blowing wool | 10.57 | 60.0 | 3.43 | 0.32 | 14 |

NOTES:
1. Values shown for the Net Unit Incremental Cost and the Cost Performance Index are calculated assuming the same type of insulation material is used in conventional practice as employed in the costed system.
2. NUIC values are per unit ceiling area.
3. G/F = glass fibre

### 6.5.2 Conventional: RSI 7.04 (R-40) Glass Fibre Blowing Wool

CPI values ranged from 14 to 19.

## 6.6 OBSERVATIONS

1. Relatively high CPI values were found for all the ceiling systems, despite the conventional ceiling's use of a high level of insulation, RSI 7.04 (R-40). For example, all of the ceiling systems investigated were found to have higher CPI values than wall systems which used 38x140 (2x6) construction for conventional practice and were being considered for upgrading.

## SECTION 7

## WINDOWS

### 7.1 WINDOW TECHNOLOGY

Residential window design evolved at a leisurely pace until the mid-1980's when a host of new technologies became available to improve their thermal performance. These included insulated edge spacers, low emittance surface treatments, reflective films and low conductance gas fills. All are now commercially available and the window industry is continuing to develop methods for improving thermal performance using these and other techniques.

Unfortunately, the energy performance of window systems is difficult to assess compared to other building envelope or mechanical system alternatives. A window's impact upon a house's energy consumption is influenced by four inter-related factors: thermal resistance, shading coefficient (or solar heat gain coefficient), air leakage and orientation. The first three are a function of the window's design while the fourth is defined by the house layout. Attempts to describe a window's performance using one, two, or even three of these factors can produce misleading conclusions. This problem is now being addressed by the introduction of the Energy Rating (ER) concept for describing window performance, however in this report only the thermal resistance and shading coefficient of the insulated glazed unit were used to express the window's performance.

### 7.2 CONVENTIONAL PRACTICE

The most common window type in eastern Canada and the west coast is the double-glazed unit with metal spacers, usually manufactured with insulating sealed glass units and dry air spaces. On the prairies and in the north, triple-glazing predominates because of the need to reduce heat loss and control winter condensation. Wood is probably the most common frame material although vinyl, metal and metal-clad wood are also frequently used.

### 7.3 SYSTEM OPTIONS ANALYZED

Thirteen window configurations were analyzed using data quoted by three Manitoba manufacturers for a non-operating wood unit with a 163 mm (6 7/16") jamb. Costs were quoted for a standard window size of approximately 1.016 m x 1.016 m (40"x40"), or the closest stock size available, and then analyzed on a unit glass area basis. Comparisons were made to double and triple-glazed windows of conventional design.

### 7.4 INCREMENTAL COSTS

The Net Unit Incremental Costs, along with the thermal resistance and shading coefficients for the conventional and upgraded window systems are

summarized in Table 5. Thermal resistance and shading coefficient values were calculated for the glazed area only (i.e. the centre and perimeter area with the effects of the frame ignored) using the WINDOW 3.1 computer program. The cost data was then refined, as shown in Table 6, to determine the incremental costs of individual upgrade components based on comparisons between windows (usually) from the same manufacturer. Costs were calculated in this fashion for the following options: triple-glazing, butyl/metal spacers, argon gas fills, low E films and reflective glazing films.

The cost to upgrade from conventional double to triple-glazing was found to vary from $30.12/m² to $51.65/m² ($2.80/ft² to $4.80/ft²), depending on the manufacturer. Butyl/metal spacers, as a substitute for conventional metal units, were quoted by one manufacturer at $5.00 per spacer for the window size studied, giving Net Unit Incremental Costs of $5.59/m² ($0.52/ft²) for double-glazing and $11.19/m² ($1.04/ft²) for triple-glazing.

The cost of low conductance argon gas fills varied significantly, even though the prices were supplied by a single manufacturer. Extrapolating the data in Table 6, the NUIC of a single argon gas space was $9.68/m² to $14.53/m² ($0.90/ft² to $1.35/ft²).

Large variations were also noted in the cost of Low E films. One manufacturer's quoted price was 2.5 times that of another giving incremental costs for a single low E film of $19.37/m² to $48.53/m² ($1.80/ft² to $4.51/ft²).

Heat Mirror 66 and 88, as substitutes for the middle pane of a triple-glazed unit, were quoted at $59.71/m² and $55.41/m² ($5.55/ft² and $5.15/ft²) respectively. However, direct comparisons between Heat Mirror 66 and the other options are misleading because the former is designed to reduce summer solar gains whereas the others are used to minimize winter heat loss.

It should be stressed that the variations in quoted costs between the different manufacturers may be indicative of the normal maturation process for any new technology. Although these options are commercially available, manufacturing processes, marketing costs and other expenses are still evolving and could result in significant price reductions in the near future.

## TABLE 5
## WINDOW SYSTEMS

| | CONVENTIONAL WINDOW | THERMAL RESISTANCE[1] RSI | R | SHADING COEFFICIENT | NUIC $/m² | $/ft² |
|---|---|---|---|---|---|---|
| Conventional double-glazing, metal spacer, 13 mm (1/2") air space. | | 0.34 | 1.91 | 0.89 | | |
| | **SYSTEM** | | | | | |
| F-1(a) | Conventional triple glazing, metal spacers, 13 mm (1/2") air spaces. | 0.48 | 2.71 | 0.79 | 30.12 | 2.80 |
| F-1(b) | Conventional triple-glazing, metal spacers, 13 mm (1/2") air spaces. | 0.48 | 2.71 | 0.79 | 51.65 | 4.80 |
| F-2 | Double-glazing, butyl/metal spacer, 13 mm (1/2") air space. | 0.35 | 1.96 | 0.89 | 5.59 | 0.52 |
| F-10 | Double-glazing, 1 low E film, metal spacer, 13 mm (1/2") argon spacer. | 0.55 | 3.12 | 0.74 | 48.52 | 4.51 |
| F-11 | Double-glazing, 1 low E film, butyl/metal spacer, 13 mm (1/2") argon space. | 0.61 | 3.47 | 0.74 | 54.12 | 5.03 |
| | **CONVENTIONAL WINDOW** | | | | | |
| Conventional triple-glazing, metal spacers, 13 mm (1/2") air spaces. | | 0.48 | 2.71 | 0.79 | | |
| | **SYSTEM** | | | | | |
| F-3 | Triple-glazing, butyl/metal spacers, 13 mm (1/2") air spaces. | 0.52 | 2.93 | 0.79 | 11.19 | 1.04 |
| F-4 | Triple-glazing, 1 low E film, metal spacers, 13 mm (1/2") air spaces. | 0.60 | 3.41 | 0.66 | 19.37 | 1.80 |
| F-5 | Triple-glazing, 2 low E films, metal spacers, 13 mm (1/2") air spaces. | 0.69 | 3.94 | 0.58 | 38.74 | 3.60 |
| F-6(a) | Triple-glazing, 1 low E film, metal spacers, 13 mm (1/2") argon spaces. | 0.67 | 3.79 | 0.66 | 48.53 | 4.51 |
| F-6(b) | Triple-glazing, 1 low E film, metal spacers, 13 mm (1/2") argon spaces. | 0.67 | 3.79 | 0.66 | 48.42 | 4.50 |
| F-7(a) | Triple-glazing, 2 low E films, metal spacers, 13 mm (1/2") argon spaces. | 0.79 | 4.46 | 0.58 | 97.06 | 9.02 |
| F-7(b) | Triple-glazing, 2 low E films, metal spacers, 13 mm (1/2") argon spaces. | 0.79 | 4.46 | 0.58 | 58.10 | 5.40 |
| F-8 | Triple-glazing, 1 low E film, butyl/metal spacers, 13 mm (1/2") argon spaces. | 0.78 | 4.44 | 0.66 | 59.72 | 5.55 |
| F-9 | Triple-glazing, 2 low E films butyl/metal spacers, 13 mm (1/2") argon spaces. | 0.97 | 5.52 | 0.58 | 108.25 | 10.06 |
| | **CONVENTIONAL WINDOW** | | | | | |
| Triple-glazing, butyl/metal spacers, 13 mm (1/2") air spaces. | | 0.52 | 2.93 | 0.79 | | |
| | **SYSTEM** | | | | | |
| F-12 | Triple-glazing, Heat Mirror 66 film, metal spacers, 13 mm (1/2") air spaces. | 0.60 | 3.41 | 0.45 | 48.52 | 4.51 |
| F-13 | Triple-glazing, Heat Mirror 88 film, metal spacers, 13 mm (1/2") air spaces. | 0.57 | 3.26 | 0.67 | 44.22 | 4.11 |

NOTES:
1. Thermal resistance values based on glazed area only, i.e. effects of the frame are ignored.

## TABLE 6
## COSTS OF WINDOW OPTIONS

| OPTION | COMPARISON | MANUFACTURER | NET UNIT INCREMENTAL COSTS $/m^2$ | $/ft^2$ |
|---|---|---|---|---|
| TRIPLE-GLAZING | F-1(a) | A | 30.12 | 2.80 |
| | F-1(b) | C | 51.65 | 4.80 |
| BUTYL/METAL SPACER | | | | |
| One spacer (i.e. for double-glazing) | F-2 | A | 5.59 | 0.52 |
| | F-11 minus F-10 | A | 5.59 | 0.52 |
| Two spacers (i.e. for triple-glazing) | F-3 | A | 11.19 | 1.04 |
| | F-8 minus F-6(a) | A | 11.19 | 1.04 |
| | F-9 minus F-7(a) | A | 11.19 | 1.04 |
| ARGON GAS FILL | | | | |
| Two spaces (i.e. for triple-glazing) | F-6(b) minus F-4 | C | 29.05 | 2.70 |
| | F-7(b) minus F-5 | C | 19.36 | 1.80 |
| LOW E FILMS | | | | |
| One additional film (i.e. upgrading from single to double Low E) | F-7(a) minus F-6(a) | A | 48.53 | 4.51 |
| | F-9 minus F-8 | A | 48.53 | 4.51 |
| | F-4 | C | 19.37 | 1.80 |
| Two films | F-5 | C | 38.74 | 3.60 |
| HEAT MIRROR 66 | F-12 plus estimated cost of butyl/metal spacers[1] | B | 59.71 | 5.55 |
| HEAT MIRROR 88 | F-13 plus estimated cost of butyl/metal spacers[1] | B | 55.41 | 5.15 |

**NOTES:**
1. Cost of butyl/metal spacer estimated from data supplied by manufacturer A.

## SECTION 8

## AIRTIGHTNESS

### 8.1 AIRTIGHTNESS IN RESIDENTIAL CONSTRUCTION

For many builders, airtightness is the most difficult conservation system to estimate the cost of since it consists of a number of small measures which can be used in different combinations with varying degrees of effectiveness. For this study, 25 airtightness "components" were defined, each relating to a specific part of the envelope. The airtightness components were then assembled in various combinations to form four airtightness "systems" for the reference bungalow described in Section 2. The incremental costs are summarized in Table 7. Conventional practice was assumed to be 4 mil polyethylene stapled in place but not sealed, with pieces of batt insulation stuffed into major holes.

Data Sheets A-1 through A-25 describe the costing information on the system components while A-26 to A-29 summarize the four complete systems. Each Data Sheet also contains a description of conventional practice and an estimate of the incremental time requirements (hours:minutes) of the system, with a breakdown by subtrade.

Unlike other building envelope components whose energy performance can be estimated using their RSI value, no comparable indicator exists to describe the performance of an airtightness component. The airtightness test using the blower door technique is in widespread use, however it characterizes the behaviour of the entire envelope and provides no information on individual components. Inspections of the envelope can of course be useful for identifying leakage areas but these are only general indicators of a component's performance. As a result, no equivalent of the Cost Performance Index is available to describe airtightness. However, differences in performance between competing systems can be quite pronounced and should be considered, as best as possible.

### 8.2 SYSTEM COMPONENTS

The individual airtightness components are discussed below. Table 8 summarizes the material costs for various types of joint sealant systems used by these components.

Some caution should be exercised in the application of the data which follows since for some of the airtightness components, there is little empirical data on their initial performance, durability and (in particular) their long-term performance.

## *TABLE 7*
## AIRTIGHTNESS COMPONENTS AND SYSTEMS

| AIRTIGHTNESS COMPONENTS | | INCREMENTAL COST PER HOUSE |
|---|---|---|
| A-1 | Material; main floor, 6 mil polyethylene air/vapour barrier | $ 17.48 |
| A-2 | Material; basement, 6 mil polyethylene air/vapour barrier | 8.03 |
| A-3 | Main floor walls; continuous, sealed polyethylene air/vapour barrier | 29.37 |
| A-4 | Basement walls; continuous, sealed polyethylene air/vapour barrier | 46.84 |
| A-5 | Wall/header; exterior air retarder | 123.11 |
| A-6 | Doors and windows; ethafoam rod | 30.86 |
| A-7 | Doors and windows; poly-wrap | 84.10 |
| A-8 | Doors and windows; urethane | 17.84 |
| A-9 | Doors and windows; poly-return | 43.71 |
| A-10 | Doors and windows; casing tape | 21.88 |
| A-11 | Wall/floor/foundation; polyethylene air/vapour barrier | 48.98 |
| A-12 | Wall/floor/foundation; Tyvek air retarder | 59.04 |
| A-13(a) | Wall/floor/cast-in-place foundation; gasket sealing | 78.37 |
| A-13(b) | Wall/floor/sill plate foundation; gasket sealing | 118.57 |
| A-14 | Ceiling; polyethylene air/vapour barrier sealed to partition walls | 41.42 |
| A-15 | Ceiling; continuous sealed polyethylene air/vapour barrier | -11.81 |
| A-16 | Ceiling; continuous taped drywall air barrier (ADA) | -20.29 |
| A-17 | Ceiling; continuous taped drywall air barrier (ADA), polyethylene vapour barrier | -20.29 |
| A-18 | Headers; interior rigid air/vapour barrier | 167.61 |
| A-19(a) | Headers; header insulation polyethylene bags with RSI 2.11 (R-12.0) | -36.66 |
| A-19(b) | Headers; header insulation polyethylene bags with RSI 3.52 (R-20.0) | -18.06 |
| A-20 | Electrical outlets, main floor; rigid polyethylene pans | 11.36 |
| A-21 | Service penetrations | 16.25 |
| A-22 | Exterior attic hatch | 0 |
| A-23 | Sealed floor drain cover | 19.95 |
| A-24 | Paint vapour barrier, main walls and ceiling | 60.45 |
| A-25 | Paint vapour barrier, basement walls | 24.16 |
| | **AIRTIGHTNESS SYSTEMS** | |
| A-26 | Sealed polyethylene air/vapour barrier | |
| | (a) Main floor only | $213.82 |
| | (b) Main floor and basement | 260.66 |
| | (c) Main floor only but with urethane foam (A-8) to seal door and window penetrations | 147.56 |
| | (d) Main floor and basement but with urethane foam (A-8) to seal door and window penetrations | 194.40 |
| A-27 | Airtight drywall approach, paint vapour barrier | |
| | (a) Main floor only | 177.00 |
| | (b) Main floor and basement | 201.16 |
| A-28 | Airtight drywall approach, polyethylene vapour barrier (finished or unfinished basement) | 116.55 |
| A-29 | Fibreglas Canada Inc. Low Energy House System | |
| | (a) Finished basement | 81.92 |
| | (b) Unfinished basement | 106.08 |

## TABLE 8

## JOINT SEALANT SYSTEMS - MATERIAL COSTS

| |
|---|
| Acoustical sealant, 6 mm (¼") bead - 18.0 ¢/m (5.5 ¢/ft) |
| Ethafoam rod:<br>6 mm (¼") - 7.9 ¢/m (2.40 ¢/ft)<br>10 mm (⅜") - 10.3 ¢/m (3.15 ¢/ft)<br>13 mm (½") - 14.4 ¢/m (4.40 ¢/ft)<br>16 mm (⅝") - 22.2 ¢/m (6.76 ¢/ft)<br>19 mm (¾") - 29.3 ¢/m (8.92 ¢/ft)<br>25 mm (1") - 47.6 ¢/m (14.5 ¢/ft) |
| Closed cell neoprene sponge gasket, self adhesive, 6 mm x 10 mm (¼" x ⅜") - 32.5 ¢/m (9.9 ¢/ft) |
| Open cell neoprene sponge gasket, self adhesive, 6 mm x 10 mm (¼" x ⅜") - 48.9 ¢/m (14.9 ¢/ft) |
| 89 mm (3½") polyethylene sill plate gasket, 6 mm (¼") thick - 31.8 ¢/m (9.7 ¢/ft) |
| 140 mm (5½") polyethylene sill plate gasket, 6 mm (¼") thick - 48.9 ¢/m (14.9 ¢/ft) |

### 8.2.1 Materials

Four mil polyethylene is the most common air/vapour barrier material used in conventional construction. In R-2000 housing, a thicker material, 6 mil, is generally used to provide extra durability. The incremental costs were calculated assuming conventional polyethylene was used, i.e. it did not meet the requirements of CAN2-51.34.M86 (CGSB 1986). The incremental material costs (excluding any additional sealing) of 6 mil polyethylene was estimated to be $17.48 for the main floor walls and ceiling and $8.03 for the basement walls.

### 8.2.2 Main Walls

Polyethylene is usually secured in place on the main wall and basement framing using staples. To seal the material and permit it to function as an air/vapour barrier, continuous beads of acoustical sealant were applied along the top and bottom plates and at lap joints. In addition, a sill plate gasket was assumed under the bottom plate of the interior basement wall framing to account for unevenness in the slab. Sealing of doors, windows, electrical outlets, headers and the ceiling were costed separately. Installation of the polyethylene was assumed to take place prior to partition wall framing. Based on these assumptions, the estimated costs of sealing the air/vapour barrier on the main walls and basement were $29.37 and $46.84 respectively. The relatively high cost for the basement was due to the bottom plate gasket.

### 8.2.3 Wall/Header

A single option was studied for providing an exterior air retarder over the main walls and headers using Tyvek. This system eliminated the requirement for building paper but required taping of all joints, edges and penetrations. The material is available in rolls or pre-attached to sheets of Glasclad sheathing. The stand-alone sheet roll system was estimated to cost $123.11, which included caulking of the joint between the header or sill plate and the foundation.

### 8.2.4 Doors and Windows

The most common method of controlling air leakage through door and window rough-openings is to pack pieces of glass fibre batts into the space between the wall framing and the jamb. The wall polyethylene is then stapled to the rough-opening. Five alternatives to this approach were studied: ethafoam rods, the poly-wrap approach, single component urethane foam, a poly-return method (in which the wall polyethylene is extended up to the window frame with sufficient slack to permit it to be sealed against the frame) and the casing tape technique in which contractor's sheathing tape is applied over the gap between the drywall and the face of the window frame. Costs of these systems were estimated to range from $17.84 to $84.10.

### 8.2.5 Wall/Floor/Foundation

The wall/floor/foundation intersection is usually unsealed and relies upon the exterior cladding to provide airtightness. If stucco is used, particularly with a cast-in-place floor system, this can result in a very effective barrier to air leakage provided, of course, the stucco remains intact. With other cladding systems, this can be the house's dominant leakage location. Three systems to control air movement were costed; these used polyethylene, Tyvek and gaskets, respectively, for sealing. Details are provided on Data Sheets A-11 through A-13. Costs ranged from $48.98 to $118.57. It should be noted that Component A-13 considered gasket sealing techniques for both cast-in-place and sill plate foundations with the latter costing approximately 50% more.

### 8.2.6 Ceiling

The ceiling is conventionally handled using polyethylene across the ceiling area which is stapled to narrow strips of the same material installed between the top plates of partition walls and to the polyethylene on the main walls. Since no sealant is used, air leakage, particularly at partition walls, is frequently a problem. Five alternative approaches were studied. The first, A-14, in which the ceiling polyethylene was sealed to the partition wall polyethylene, had an estimated incremental cost of $41.42. (Sealing at the main wall/ceiling joint is included under the "Main Floor Walls" components.) Components A-15 through A-17 considered continuous sealed polyethylene as the air/vapour barrier, taped drywall as the air barrier (with the paint serving as the vapour barrier - costed separately) and continuous drywall as the air barrier but with 4 mil polyethylene serving as the vapour barrier. All three of these systems produced cost savings relative to conventional practice (ranging from $11.81 to $20.29) provided the ceiling drywall (and polyethylene if included) were installed prior to the partition walls and that there was no additional charge for any subtrade rescheduling. Note that Components A-16 and A-17 produce the same incremental cost saving relative to conventional practice because the credit for the polyethylene eliminated in A-16 appears in Component A-24.

### 8.2.7 Headers

Two alternative header sealing systems were studied: the first using pieces of extruded polystyrene cut, fitted and sealed into place in the header spaces to serve as an air/vapour barrier. The second approach used a product consisting of glass fibre batt-filled polyethylene bags (Fibreglas Canada "Header Insulation") which were packed but not sealed into the header space. Conventional practice is to staple, but not seal, polyethylene into the header space. The first option, A-18, was estimated to cost $167.61, indicative of the significant time required. The second, A-19, produced cost savings relative to conventional practice because of the rapid installation time. This system would serve as a vapour barrier although it is unknown if it could sustain sufficient pressure differentials to function as an air barrier.

### 8.2.8 Service Penetrations

Conventionally these are poorly sealed or completely ignored. Interestingly, the total cost to seal the service penetrations, when calculated, was found to be relatively modest.

### 8.2.9 Paint Vapour Barrier

If a structural air barrier system is used without a sufficiently low permeability to water vapour, a separate vapour barrier (or more accurately a vapour retarder) has to be employed. Two alternatives are to use either conventional 4 mil polyethylene or the painted surface of the drywall as the vapour barrier. Component A-24 and A-25 describe the paint vapour barrier approach for the main walls and ceiling and the basement walls. Costs were estimated at $60.45 and $24.16, respectively. In each case an additional oil base primer was applied between the latex primer and the finish coat since oil base primers may raise the nap of paper-coated drywall. If an oil base finish coat was acceptable, then only two coats would be required (latex primer and oil base finish coat). Costs for the main walls were developed on the assumption that partition walls were painted as per conventional practice.

## 8.3 COMPLETE AIRTIGHTNESS SYSTEMS

### 8.3.1 Polyethylene Air/Vapour Barrier Envelope (A-26)

This system basically represents the "polyethylene approach" to airtightness and was analyzed in four variations, as shown in Table 8. The first consisted of sealing only the main floor with the basement unaltered from conventional practice (i.e. stapled, but not sealed polyethylene on the walls). Experience has shown that in some cases, basement leakage is sufficiently low to not require special sealing measures. For these situations, the incremental cost was estimated at $213.82. If basement sealing were included, the cost would increase to $260.66. Reviewing the component costs, it was discovered that almost 40% of the total cost of the sealed polyethylene air/vapour barrier approach was for sealing the door and window rough-openings with the poly-wrap approach, Component A-7, (the most commonly used method in R-2000 construction). As an alternative, single-component urethane foam was substituted for sealing the door and window rough-openings. Using the same scenarios described above, the cost of sealing the main floor only was reduced to $147.56 while the cost of sealing the main floor and basement was estimated at $194.40.

### 8.3.2 Airtight Drywall Approach, Paint Vapour Barrier (A-27)

This system uses the ADA approach with paint as the vapour barrier. The total incremental cost was estimated at $177.00 with the two major costs being the wall/floor/foundation gasket systems ($78.37) and the paint vapour barrier for the main walls and ceiling ($60.45). The basement was assumed to be unfinished. If the basement was finished, the cost would increase to $201.16.

### 8.3.3 Airtight Drywall Approach, Polyethylene Vapour Barrier (A-28)

This system is similar to conventional construction since 4 mil polyethylene is used as the vapour barrier for the main walls and ceiling. It is basically identical to System A-27 except that the painted vapour barrier is eliminated. The total incremental system cost was estimated at $116.55 for either a finished or unfinished basement since the conventional 4 mil polyethylene on the basement walls is not affected.

### 8.3.4 Fiberglas Canada Inc. Low Energy House System (A-29)

The FCI LEHS is a modified ADA system designed to provide reasonable airtightness at minimal cost and is intended to be operated in conjunction with the Habitair energy system which maintains the home under a slight negative pressure differential so that uncontrolled air movement is always inward across the envelope. It also assumes that Glasclad sheathing is used. The total incremental cost was estimated at $81.92 for an unfinished basement and $106.08 for a finished basement.

## 8.4 OBSERVATIONS

1. The polyethylene approach normally used in R-2000 construction was the most expensive of the complete airtightness systems studied. However, with relatively minor modifications, such as changing the door and window rough-opening sealing method, the incremental cost was reduced to a level equal to the ADA system.

2. The cost effectiveness of the ADA system was significantly improved by the use of 4 mil polyethylene rather than paint as the vapour barrier and required fewer changes from conventional practice.

3. The Fiberglas Canada Inc. Low Energy House System had the lowest incremental cost. This could be further reduced by the use of polyethylene instead of paint as the vapour barrier. However this system requires a modified wall and mechanical system which were not included in the cost of the airtightness measures.

4. There is an opportunity to improve the cost-effectiveness of the complete airtightness systems by cost optimization using alternative system components, as was demonstrated with the polyethylene air/vapour barrier approach.

5. There is a need for empirical, performance data on the comparative air leakage characteristics of the various airtightness components. This information should be produced and integrated with the cost data to permit the development of more cost-effective, low leakage airtightness systems.

## SECTION 9

## VENTILATION SYSTEMS

### 9.1 INTRODUCTION

The purpose of the ventilation system is twofold: to remove contaminated air and to supply outdoor air in a well-distributed manner. In conventional, leaky houses, a portion of the ventilation requirements is met by natural infiltration. With tighter envelopes, a mechanical ventilation system becomes increasingly important. In R-2000 houses, mechanical ventilation systems must be installed to comply with CSA F326 "Residential Mechanical Ventilation Systems" (CSA 1991).

Eleven ventilation components were studied and then assembled into eight complete ventilation systems, as summarized on Data Sheets V-1 to V-19.

### 9.2 CONVENTIONAL PRACTICE

The type of conventional ventilation system tends to vary with geographic location, house size, house type and with builder. For this study the system was assumed to consist of:

- Fresh air intake,
- Kitchen exhaust fan, and
- Bathroom exhaust fan.

Incremental costs for the complete ventilation systems (V-12 to V-19) were calculated with respect to this system. Although the conventional ventilation system is shown as an alternative, its performance and capabilities would be considerably less than the complete systems analyzed, particularly with respect to their ability to maintain acceptable indoor air quality.

### 9.3 SYSTEM COMPONENTS

Table 9 summarizes the gross installed costs of the 11 ventilation system components. The Heat Recovery Ventilators (Systems V-5 and V-6) are typical of the units found in R-2000 construction; the small unit (V-5) would be suitable for houses up to approximately 139 $m^2$ (1500 $ft^2$) and the medium capacity unit could be used in houses up to about 279 $m^2$ (3000 $ft^2$). System V-7 is an HRV which uses a heat pump, instead of a heat exchanger, to transfer heat between the exhaust and supply air streams. In terms of ventilation capacity, it is comparable to the medium capacity HRV (V-6). Also worthy of note is V-8, a dedicated ventilation-only supply air system. This could be used to provide ventilation air in R-2000 houses (or others designed to meet CSA F326) with baseboard heating systems.

## TABLE 9
## VENTILATION SYSTEM COMPONENTS

| SYSTEM COMPONENT | | DESCRIPTION | GROSS COST (INSTALLED) |
|---|---|---|---|
| V-1 | Fresh air intake | 127 mm (5") fresh air intake from outdoors to return air plenum | $ 45.00 |
| V-2 | Kitchen exhaust fan | 61 l/s (130 CFM) (free stream capacity) kitchen exhaust fan | 120.00 |
| V-3 | Bathroom exhaust fan | 24 l/s (50 CFM) (free stream capacity) bathroom exhaust fan | 86.00 |
| V-4 | Central exhaust | 113 l/s (240 CFM) (free stream capacity) central exhaust drawing from kitchen and bathroom | 439.00 |
| V-5 | Heat Recovery Ventilator, small capacity | 47 l/s (100 CFM) HRV exhausting from kitchen and bathroom and supplying to return air plenum or dedicated ventilation-only supply system | 1,442.00 |
| V-6 | Heat Recovery Ventilator, medium capacity | 102 l/s (216 CFM) HRV exhausting from kitchen and bathroom and supplying to return air plenum or dedicated ventilation-only supply system | 1,742.00 |
| V-7 | Heat Pump Heat Recovery Ventilator | 125 l/s (265 CFM) heat pump HRV exhausting from kitchen and bathroom and supplying to return air plenum or dedicated ventilation-only supply system | 2,698.00 |
| V-8 | Dedicated Ventilation-Only Supply System | Ventilation-only duct system with 152mm (6") main and 102mm (4") branch ducts from HRV (or supply fan) to 5 main floor and 2 basement registers. High sidewall supplies on main floor | 475.00 |
| V-9 | Dehumidistat | 110 VAC dehumidistat installed in hallway to operate HRV or exhaust fan | 81.00 |
| V-10 | Duct heater | 2 kW duct heater in 152mm (6") fresh air duct | 370.00 |
| V-11 | Automatic damper | Automatic air controlled damper in 152mm (6") duct c/w switch | 121.00 |

## 9.4 COMPLETE VENTILATION SYSTEMS

As shown in Table 10, System V-12 is the conventional ventilation system while V-13 to V-19 use the three HRV's combined with either forced air or baseboard heating systems. Although Systems V-16 to V-19 would be oversized for a house the size for a structure the size of the reference house, they have been included to document their incremental costs.

## 9.5 OBSERVATIONS

1. The cost of the ventilation system was largely determined by the type of system and not the size of the house. Since ventilation usually accounts for a large percentage of a house's heating load, builders should ensure that a system with good heat recovery performance is used. In larger houses, with higher ventilation loads, HRV's with the highest efficiencies should be used.

2. Although the HRV systems provide superior ventilation in terms of air delivery, distribution and energy savings, there was a significant cost gap between them and the conventional system. While perhaps unavoidable, it does suggest that greater effort be directed at reducing installed HRV system costs, particularly if other methods of controlling indoor air quality (such as pollutant source removal or containment) can be used to permit reduced ventilation rates and attendant energy costs.

## TABLE 10
## COMPLETE VENTILATION SYSTEMS

| SYSTEM | | DESCRIPTION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|---|
| V-12 | Conventional ventilation system | • Fresh air intake (V-1)<br>• Kitchen exhaust fan (V-2)<br>• Bathroom exhaust fan (V-3) | $ 257.00 | $ 0 | $ 257.00 |
| V-13 | Central exhaust system | • Fresh air intake (V-1)<br>• Central exhaust (V-4)<br>• Dehumidistat (V-9) | 565.00 | 257.00 | 308.00 |
| V-14 | HRV system, small capacity, for use with a forced air heating system | • HRV, small capacity (V-5)<br>• Dehumidistat (V-9) | 1,523.00 | 257.00 | 1,266.00 |
| V-15 | HRV system, small capacity, for use with a baseboard heating system | • HRV, small capacity (V-5)<br>• Dedicated ventilation-only supply system (V-8)<br>• Dehumidistat (V-9) | 1,998.00 | 257.00 | 1,741.00 |
| V-16 | HRV system, medium capacity, for use with a forced air heating system | • HRV, medium capacity (V-6)<br>• Dehumidistat (V-9) | 1,823.00 | 257.00 | 1,566.00 |
| V-17 | HRV system, medium capacity, for use with a baseboard heating system | • HRV, medium capacity (V-6)<br>• Dedicated ventilation-only supply system (V-8)<br>• Dehumidistat (V-9) | 2,298.00 | 257.00 | 2,041.00 |
| V-18 | Heat pump HRV for use with a forced air heating system | • Heat pump HRV (V-7) | 2,698.00 | 257.00 | 2,441.00 |
| V-19 | Heat pump HRV for use with a baseboard heating system | • Heat pump HRV (V-7)<br>• Dedicated ventilation-only supply system (V-8) | 3,173.00 | 257.00 | 2,916.00 |

## SECTION 10

## HEATING SYSTEMS

### 10.1 CONVENTIONAL PRACTICE

Conventional practice for heating systems tends to vary by geographic location and with utility rates. For this study, the conventional heating system was assumed to be a naturally aspirated, forced-air gas furnace with a seasonal efficiency of 60%. Conventional floor-mounted registers, located under windows, were used on the main floor with ceiling-mounted registers in the basement. Two return registers were assumed - one in the main hallway and one in the basement. Note however that this system would not be permitted in R-2000 construction since it uses a naturally aspirated appliance.

### 10.2 SYSTEMS ANALYZED

Table 11 summarizes the ten systems studied. Six complete systems using gas or electric heat were costed; System H-7, high-sidewall supply registers for a forced air heating system, is an option used to minimize drafts from the supply registers with a continuous circulation furnace blower. Conventional, as opposed to "high-throw", grilles were assumed. System H-8, individual room air returns for a forced air system, would be used to provide better air circulation throughout the house. Doors will normally restrict air flow into a closed room if the undercut is small. Two air-conditioning options were also studied, H-9 and H-10.

### 10.3 OBSERVATIONS

1. As a general recommendation, higher efficiency furnaces would be most cost effective in houses with larger gross heating loads since the cost of the furnace is largely independent of house size and the extra cost of the unit can be applied against the larger heating load. Thus, for small and medium sized houses, an induced draft unit would generally be the most appropriate upgrade from a naturally aspirated gas furnace while in a large structure, a condensing unit would be more cost effective.

2. The incremental cost of high sidewall supplies was $95 or approximately $16 per register which many would view as a reasonable cost for the improved comfort. The incremental cost of the individual room returns was $115 or approximately $38 per register. Some opportunities may exist for optimization of both systems.

## TABLE 11
## HEATING SYSTEMS

| | SYSTEM DESCRIPTION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| H-1 | Conventional naturally aspirated gas furnace c/w ductwork, seasonal efficiency 60% | $1,458.00 | $ 0 | $1,458.00 |
| H-2 | Naturally aspirated gas furnace with spark ignition and vent damper c/w ductwork, seasonal efficiency 69% | 1,833.00 | 1,458.00 | 375.00 |
| H-3 | Induced draft gas furnace c/w ductwork, seasonal efficiency 80% | 2,028.00 | 1,458.00 | 570.00 |
| H-4 | Condensing gas furnace c/w ductwork, seasonal efficiency 95% | 3,058.00 | 1,458.00 | 1,600.00 |
| H-5 | 10 kW electric furnace c/w ductwork | 1,530.00 | 1,458.00 | 72.00 |
| H-6 | 8 kW electric baseboard heating system | 756.00 | 1,458.00 | -702.00 |
| | | | | NET COST (INSTALLED) |
| H-7 | High sidewall supply registers on main floor (6 registers) | | | $ 95.00 |
| H-8 | Individual room returns (3 additional registers) | | | 115.00 |
| H-9 | 0.8 ton window air conditioner | | | 613.00 |
| H-10 | 2 ton central air conditioner | | | 2,115.00 |

## SECTION 11

## DOMESTIC HOT WATER HEATING

### 11.1 CONVENTIONAL PRACTICE

Both natural gas and electric domestic hot water (DHW) tanks are in common use in Canada but for this study, conventional practice was assumed to be a 114 l (25 I.G.) gas tank.

### 11.2 SYSTEMS ANALYZED

Four DHW systems, one gas, two electric and one heat pump unit, were studied as shown in Table 12. The first three have no energy conservation features other than those adopted industry-wide, but were included for use with other system packages. Note that System D-1, the naturally aspirated gas DHW tank would not be permitted in R-2000 construction.

System D-4 is an electric heat pump DHW water heater consisting of a stand-alone module containing the compressor, evaporator, condenser, fan, circulation pump and control system. The unit is plumbed to the existing DHW tank and designed to extract low grade heat from the indoor air. For the analysis, it was assumed that the module was located directly beside the existing DHW tank thus minimizing installation costs and allowing the basement air to be used as the heat source.

### 11.3 INCREMENTAL COSTS

Total costs for Systems D-1 to D-3 were relatively similar while the heat pump unit was significantly higher, $1084.75, although it would potentially be able to make a significant reduction in the cost of heating DHW.

## TABLE 12
## DOMESTIC HOT WATER HEATING SYSTEMS

| | SYSTEM DESCRIPTION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| D-1 | Conventional 114 l (25 I.G.) naturally aspirated gas DHW tank | $ 355.00 | $ 0 | $ 355.00 |
| D-2 | Electric 182 l (40 I.G.) DHW tank | 425.00 | 355.00 | 70.00 |
| D-3 | Electric 273 l (60 I.G.) DHW tank | 547.00 | 355.00 | 192.00 |
| D-4 | Heat pump DHW heater | 1,084.75 | 0 | 1,084.75 |

## SECTION 12

## INTEGRATED SYSTEMS

### 12.1 INTRODUCTION

Integrated systems combine the functions normally performed by two or more separate mechanical system components and thereby attempt to maximize the overall efficiency of the mechanical system. Two early-generation integrated systems were investigated and are discussed separately. In both cases however, the cost analysis should be regarded as an approximation since few such systems have been installed to date. There is also some difficulty assessing their incremental costs since they combine the functions of several systems, in whole or in part. Therefore several scenarios were developed for each system.

### 12.2 HABITAIR

This system, produced by Fiberglas Canada Inc., combines the ventilation and DHW heating functions and provides partial, supplemental space heating in winter and air-conditioning in summer. The Habitair model evaluated consisted of an exhaust-only ventilation system complete with an integral heat pump which recovered energy from the exhaust air and used it to heat the DHW. In winter, once this load was met, the additional energy was made available for space heating. Conventional electric baseboard heaters or a forced air heating system, sized to the design heating load of the house, were still required. In summer, the system provided approximately 2.3 kW (8,000 Btu/hr) of cooling, with the energy extracted from the house air used for DHW heating. The Habitair included an integral 273 l (60 I.G.) DHW tank with 1,500 W of supplemental resistance heaters. The Habitair was intended for use with the Fibreglas Canada Inc. Low Energy House System.

#### 12.2.1 Costs

The total installed cost of the Habitair was estimated at $4,417.00. Since the incremental cost depended on the assumed choice for the conventional systems, four separate cases were considered, as shown in Table 13. The first (case 1) represents the Habitair replacing the conventional DHW and ventilation system in a non R-2000 house with baseboard heating. Cases 2 through 4 represent the unit installed in an R-2000 house in which a higher quality ventilation system was required and the Habitair was able to replace the HRV. Since the system also provided partial cooling, the argument can be made that the Habitair will replace an air-conditioner, either a window unit (case 3) or a central unit (case 4), although its cooling capacity would be considerably less. However, with careful envelope design to minimize solar gain in summer, it might be possible to forego installing air-conditioning. This would significantly reduce the incremental cost of the Habitair.

## TABLE 13
## HABITAIR INCREMENTAL COSTS

| CASE | TYPE OF INSTALLATION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| 1 | Habitair replaces:<br>• conventional 114 l (25 I.G.) gas DHW tank (D-1)<br>• conventional ventilation system (V-12) | $4,417.00 | $ 612.00 | $3,805.00 |
| 2 | Habitair replaces:<br>• 273 l (60 I.G.) electric DHW tank (D-3)<br>• HRV system, medium capacity, for baseboard heating (V-17) | 4,417.00 | 2,845.00 | 1,572.00 |
| 3 | Habitair replaces:<br>• 273 l (60 I.G.) electric DHW tank (D-3)<br>• HRV system, medium capacity, for baseboard heating (V-17)<br>• window air conditioner (H-9) | 4,417.00 | 3,458.00 | 959.00 |
| 4 | Habitair replaces:<br>• 273 l (60 I.G) electric DHW tank (D-3)<br>• HRV system, medium capacity, for baseboard heating (V-17)<br>• central air conditioner (H-10) | 4,417.00 | 4,960.00 | -543.00 |

## 12.3 PEACH

This system was produced by Cambridge Manufacturing Ltd. and was offered in various configurations. The example studied combined the space heating, DHW heating, ventilation and air-conditioning functions in one package and also included an outdoor air source heat pump. The integral heat pump provided energy for the heating loads, preheated the ventilation air and served as an air-conditioner. Two DHW tanks were required, a 182 l (40 I.G.) unit for preheating and a 114 l (25 I.G.) tank as a final booster. An integral 16 kW electric furnace supplied additional space heating. Since the system provided only single-speed ventilation, supplemental exhaust capacity was required (in this instance, bathroom and kitchen fans).

### 12.3.1 Costs

Total installed costs for the Peach were estimated at $6,325.00, which included the two DHW tanks and two exhaust fans. Again, incremental system costs were dependent on what existing components were replaced. In this study, five cases were explored as shown in Table 14. The first, case 1, represented the Peach replacing a conventional gas furnace, DHW tank and conventional ventilation system in a non R-2000 house. Cases 2 through 5 represent the unit installed in an R-2000 house in which an HRV would be required. Cases 2 and 3 show it replacing an all-electric system while cases 4 and 5 show the Peach displacing an induced draft gas furnace with electric DHW heating. Cases 3 and 5 include central air-conditioning. As was the case with the Habitair, the incremental costs for the Peach were significantly reduced when additional conventional components were replaced.

## 12.4 OBSERVATIONS

1. The integrated systems were most cost effective when they were able to completely replace, rather than augment, systems normally used in conventional practice. The cost effectiveness of both systems improved significantly when they eliminated an air-conditioning system.

2. Determination of the incremental costs for integrated mechanical systems is more difficult than other components used in a house and the examples discussed above should be regarded as illustrative rather than exhaustive. Further, builders should exercise care when considering integrated systems to ensure that the most cost-effective application has been found.

## TABLE 14
## PEACH INCREMENTAL COSTS

| CASE | TYPE OF INSTALLATION | GROSS COST (INSTALLED) | LESS SAVINGS (INSTALLED) | NET COST (INSTALLED) |
|---|---|---|---|---|
| 1 | Peach replaces:<br>• conventional gas furnace, 60% efficient (H-1)<br>• conventional 114 l (25 I.G.) gas DHW tank (D-1)<br>• conventional ventilation system (V-12) | $6,325.00 | $2,070.00 | $4,255.00 |
| 2 | Peach replaces:<br>• 10 kW electric furnace c/w ductwork (H-5)<br>• 273 l (60 I.G.) electric DHW tank (D-3)<br>• HRV system, medium capacity, for forced air heating (V-16) | 6,325.00 | 3,900.00 | 2,425.00 |
| 3 | Peach replaces:<br>• 10kW electric furnace c/w ductwork (H-5)<br>• 273 l (60 I.G.) electric DHW tank (D-3)<br>• HRV system, medium capacity, for forced air heating (V-16)<br>• central air conditioner (H-10) | 6,325.00 | 6,015.00 | 310.00 |
| 4 | Peach replaces:<br>• Induced draft gas furnace, 80% efficient (H-3)<br>• 273 l (60 I.G.) electric DHW tank (D-3)<br>• HRV system, medium capacity, for forced air heating (V-16) | 6,325.00 | 4,398.00 | 1,927.00 |
| 5 | Peach replaces:<br>• Induced draft gas furnace, 80% efficient (H-3)<br>• 273 l (60 I.G.) electric DHW tank (D-3)<br>• HRV system, medium capacity, for forced air heating (V-16)<br>• central air conditioner (H-10) | 6,325.00 | 6,513.00 | -188.00 |

## SECTION 13

## OPTIMIZATION OF ENERGY CONSERVATION PACKAGES

### 13.1 RECOMMENDATIONS

The costing information developed in this study has been derived for a specific house type, a given builder and in a single location. Applying this information in other situations would require adjustments to reflect individual and local circumstances. This can and should be done by those wishing to develop an accurate cost base for designing energy conservation packages. However, it is also possible to provide some general guidance with respect to the order in which different systems should be considered.

This section contains basic recommendations on how to upgrade a conventional house to the R-2000 Standard. Recommendations are presented in Table 15 for three house types and can be applied regardless of climate or energy costs. Each house type is shown with a set of "Basic Requirements" which are either explicitly required to meet R-2000 requirements or are included because they are usually needed to meet the R-2000 energy target. In some instances, the Basic Requirements alone will prove adequate, in other cases, additional measures will be needed. For the latter situations, the "Upgrade Options" should be considered. These are divided into blocks containing one or more options. Each of the options within a block have roughly the same cost effectiveness and should be investigated before considering those in the following block.

Note however that these are general guidelines developed solely on the basis of energy cost effectiveness with no consideration of other factors such as comfort, envelope moisture protection, marketability, property taxes, utility incentives or the impact upon the living space. It may be appropriate to modify them to reflect design criterion or the needs of specific applications.

## TABLE 15
## GENERAL GUIDELINES FOR OPTIMIZING ENERGY CONSERVATION PACKAGES

| | BUNGALOWS | SPLIT LEVELS, RAISED BUNGALOWS | 1 1/2 and 2 STOREY HOUSES |
|---|---|---|---|
| **BASIC REQUIREMENTS** | | | |
| Walls | RSI 3.52 (R-20) | RSI 3.52 (R-20) | RSI 3.52 (R-20) |
| Basement Walls | RSI 3.52 (R-20) | RSI 4.23 (R-24) | RSI 3.52 (R-20) |
| Ceiling | RSI 7.04 (R-40) | RSI 7.04 (R-40) | RSI 7.04 (R-40) |
| Windows | Triple-glazing | Triple-glazing | Triple-glazing |
| Airtightness System | Polyethylene or ADA | Polyethylene or ADA | Polyethylene or ADA |
| Heating System | Induced draft (80%) or electric | Induced draft (80%) or electric | Induced draft (80%) or electric |
| DHW System | Induced draft or electric | Induced draft or electric | Induced draft or electric |
| Ventilation | Medium efficiency HRV (65%) | Medium efficiency HRV (65%) | High efficiency HRV (80%) |
| **UPGRADE OPTIONS** | | | |
| First Priority | Increase basement wall insulation<br>Increase ceiling insulation<br>Use high performance windows<br>Use high efficiency HRV (80%) | Increase basement wall insulation<br>Add slab perimeter insulation<br>Use high performance windows<br>Use high efficiency HRV (80%) | Increase basement wall insulation<br>Increase ceiling insulation<br>Use high performance windows |
| Second Priority | Add slab perimeter insulation | Increase ceiling insulation | Use high efficiency furnace (90%)<br>Add slab perimeter insulation |
| Third Priority | Add slab centre insulation | Add slab centre insulation<br>Use high efficiency furnace (90%) | Add slab centre insulation<br>Increase wall insulation |
| Fourth Priority | Use high efficiency furnace (90%)<br>Increase wall insulation | Increase wall insulation | |

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# APPENDIX A

# COMPONENT AND SYSTEM DATA SHEETS

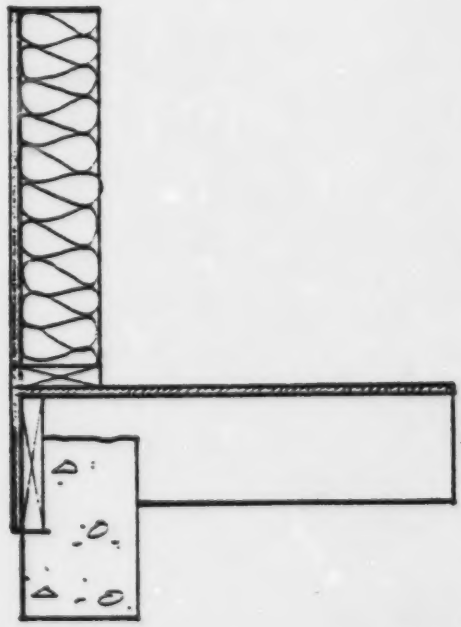
SYSTEM: 38x140 (2x6) @ 600 mm (24") with 16 mm (5/8") fibreboard sheathing

CHANGES FROM CONVENTIONAL PRACTICE:

| CONVENTIONAL - 38x89 (2x4) | CONVENTIONAL - 38x140 (2x6) |
|---|---|
| o Replace 38x89 (2x4) studs with 38x140 (2x6) | |
| o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20) | N/A |
| o Use 163 mm (6 7/16") door and window jambs | |

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $341.48 | | m |
| | 15.00 | | 1 |
| | $356.48 | N/A | |
| LESS SAVINGS: | $ 0 | | m |
| | 0 | | 1 |
| | $ 0 | N/A | |
| NET COST: | $341.48 | | m |
| | 15.00 | | 1 |
| | $356.48 | N/A | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 4.01 | $/m² |
| | 0.37 | $/ft² |
| COST PERFORMANCE INDEX: | 47 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.52 (R-20.0) | |



NOTES:
1. Insulated area does not include headers.

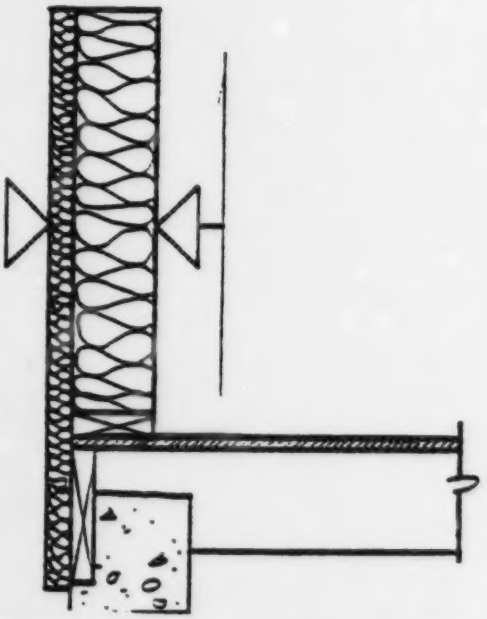
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 25 mm (1") exterior rigid glass fibre insulated sheathing c/w taped exterior air barrier, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier
- o Tape all joints with sheathing tape
- o Delete 16 mm (5/8") fibreboard sheathing
- o Delete building paper

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $ 974.51 | $633.03 | m |
| | 165.00 | 150.00 | l |
| | $1139.51 | $783.03 | |
| LESS SAVINGS: | $ 307.65 | $307.65 | m |
| | 20.00 | 20.00 | l |
| | $ 327.65 | $327.65 | |
| NET COST: | $ 666.86 | $325.38 | m |
| | 145.00 | 130.00 | l |
| | $ 811.86 | $455.38 | |
| NET UNIT INCREMENTAL COST: | 8.39 | 4.73 | $/m² |
| | 0.78 | 0.44 | $/ft² |
| COST PERFORMANCE INDEX: | 29 | 11 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.30 (R-24.4) | | |



NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

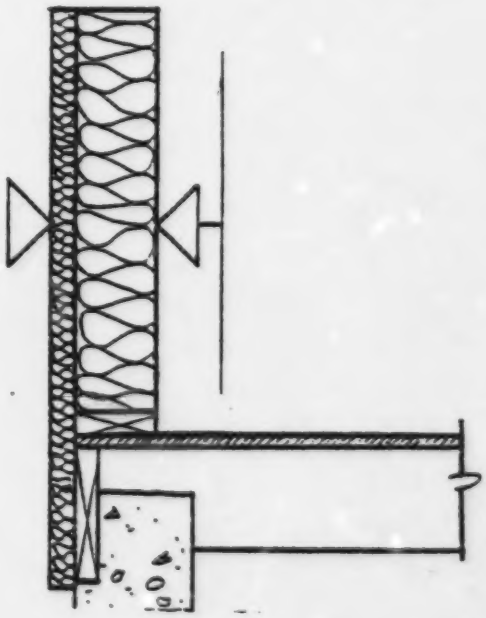
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 38 mm (1½") exterior rigid glass fibre insulated sheathing c/w taped exterior air barrier, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier
- o Tape all joints with sheathing tape
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Delete building paper

| | CONVENTIONAL WALL | | |
|---|---|---|---|
| | RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
| GROSS COST: | $1231.47 | $ 889.99 | m |
| | 217.50 | 202.50 | l |
| | $1448.97 | $1092.49 | |
| LESS SAVINGS: | $ 307.65 | $ 307.65 | m |
| | 20.00 | 20.00 | l |
| | $ 327.65 | $ 327.65 | |
| NET COST: | $ 923.82 | $ 582.34 | m |
| | 197.50 | 182.50 | l |
| | $1121.32 | $ 764.84 | |
| NET UNIT INCREMENTAL COST: | 11.62 | 7.96 | $/m² |
| | 1.08 | 0.74 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | 9 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.70 (R-26.7) | | |



NOTES:
1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

SYSTEM: 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior rigid glass fibre insulated sheathing c/w taped exterior air barrier, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

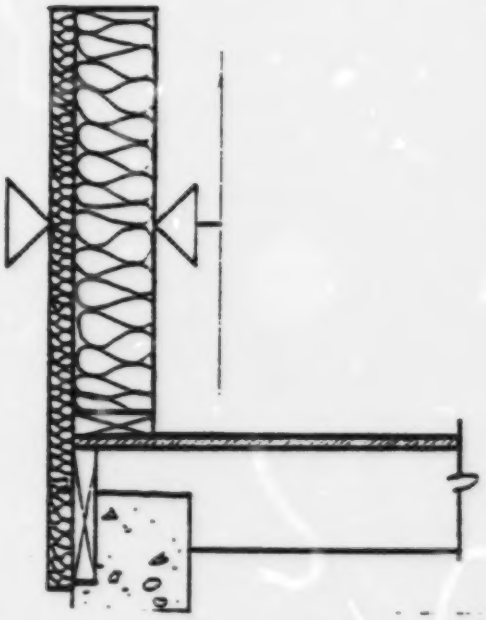
CONVENTIONAL - 38x89 (2x4)

- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier
- o Tape all joints with sheathing tape
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Delete building paper

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1440.29 | $1098.81 | m |
| | 232.50 | 217.50 | l |
| | $1672.79 | $1316.31 | |
| LESS SAVINGS: | $ 307.65 | $ 307.65 | m |
| | 20.00 | 20.00 | l |
| | $ 327.65 | $ 327.65 | |
| NET COST: | $1132.64 | $ 791.16 | m |
| | 212.50 | 197.50 | l |
| | $1345.14 | $ 988.66 | |
| NET UNIT INCREMENTAL COST: | 13.88 | 10.22 | $/m² |
| | 1.29 | 0.95 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | 8 | |
| UPGRADED THERMAL RESISTANCE: | RSI 5.07 (R-28.8) | | |



NOTES:

1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost $173.94.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

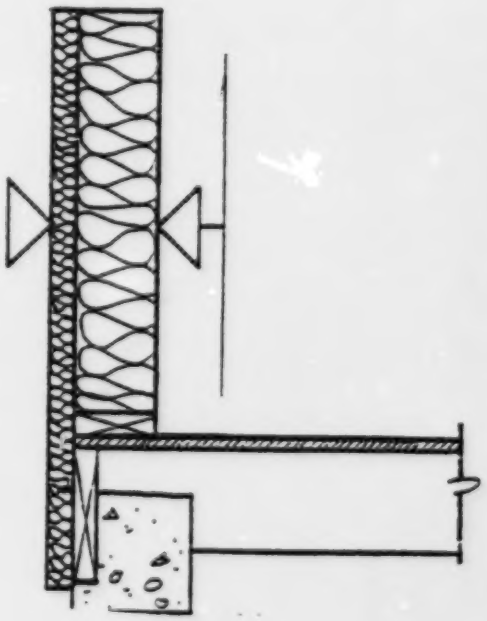
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 25 mm (1") exterior rigid glass fibre insulated sheathing c/w exterior air barrier (reversed, joints not taped), corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier (reversed)
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $ 934.11 | $ 592.63 | m |
| | 105.00 | 90.00 | l |
| | $1039.11 | $ 682.63 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $ 646.10 | $ 304.62 | m |
| | 105.00 | 90.00 | l |
| | $ 751.10 | $ 394.62 | |
| NET UNIT INCREMENTAL COST: | 7.75 | 4.09 | $/m² |
| | 0.72 | 0.38 | $/ft² |
| COST PERFORMANCE INDEX: | 31 | 13 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.30 (R-24.4) | | |



NOTES:
1. Alternate: use 163 mm (6 7/16") jambs for doors and windows without exterior returns.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

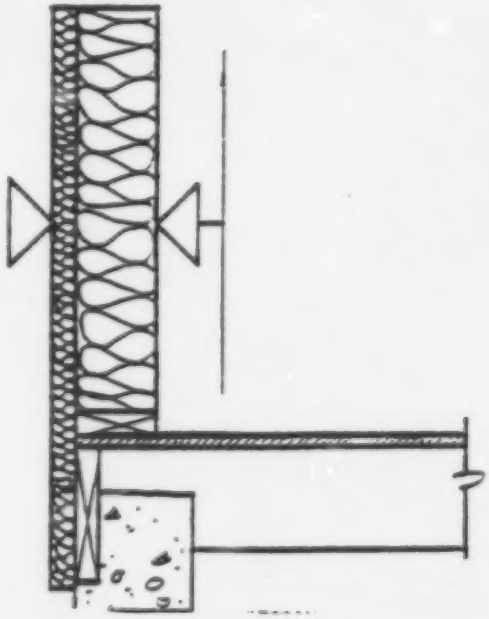
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 38 mm (1½") exterior rigid glass fibre insulated sheathing c/w exterior air barrier (reversed, joints not taped), corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier (reversed)
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1191.07 | $ 849.59 | m |
| | 172.50 | 157.50 | l |
| | $1363.57 | $1007.09 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $ 903.06 | $ 561.58 | m |
| | 172.50 | 157.50 | l |
| | $1075.56 | $ 719.08 | |
| NET UNIT INCREMENTAL COST: | 11.19 | 7.42 | $/m² |
| | 1.04 | 0.69 | $/ft² |
| COST PERFORMANCE INDEX: | 23 | 10 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.70 (R-26.7) | | |



NOTES:
1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

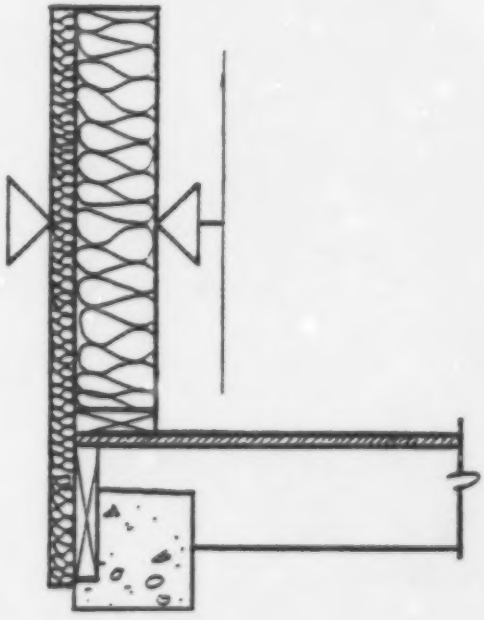
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior rigid glass fibre insulated sheathing c/w exterior air barrier (reversed, joints not taped)

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 28x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing c/w air barrier (reversed)
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1399.89 | $1058.41 | m |
| | 187.50 | 172.50 | l |
| | $1587.39 | $1230.91 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $1111.88 | $ 770.40 | m |
| | 187.50 | 172.50 | l |
| | $1299.38 | $ 942.90 | |
| NET UNIT INCREMENTAL COST: | 13.45 | 9.79 | $/m² |
| | 1.25 | 0.91 | $/ft² |
| COST PERFORMANCE INDEX: | 21 | 9 | |
| UPGRADED THERMAL RESISTANCE: | RSI 5.07 (R-28.8) | | |



NOTES:
1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost $173.94.
2. Insulated area includes headers.
3. Includes additional 10% (labour & materials) to cost of applying stucco scratchcoat.

SYSTEM: 38x89 (2x4) @ 400 mm (16") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

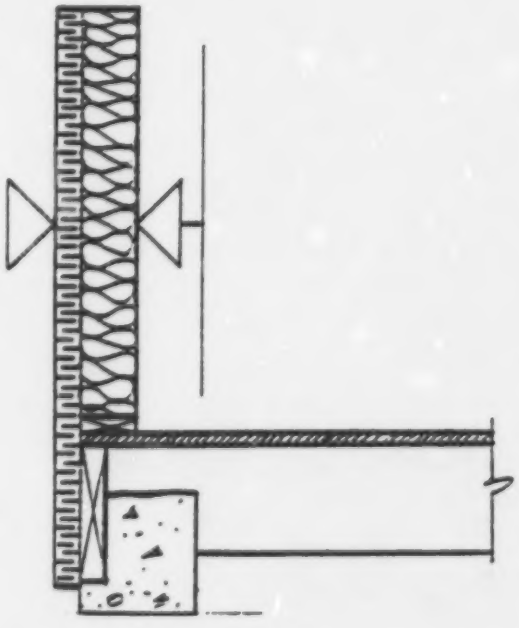
CONVENTIONAL - 38x89 (2x4)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1272.64 | $ 931.16 | m |
| | 138.75 | 123.75 | l |
| | $1411.39 | $1054.91 | |
| LESS SAVINGS: | $ 590.64 | $ 590.64 | m |
| | 6.00 | 6.00 | l |
| | $ 596.64 | $ 596.64 | |
| NET COST: | $ 682.00 | $ 340.52 | m |
| | 132.75 | 117.75 | l |
| | $ 814.75 | $ 458.27 | |
| NET UNIT INCREMENTAL COST: | 8.39 | 4.73 | $/m² |
| | 0.78 | 0.44 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | -2 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.43 (R-19.5) | | |



NOTES:

1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

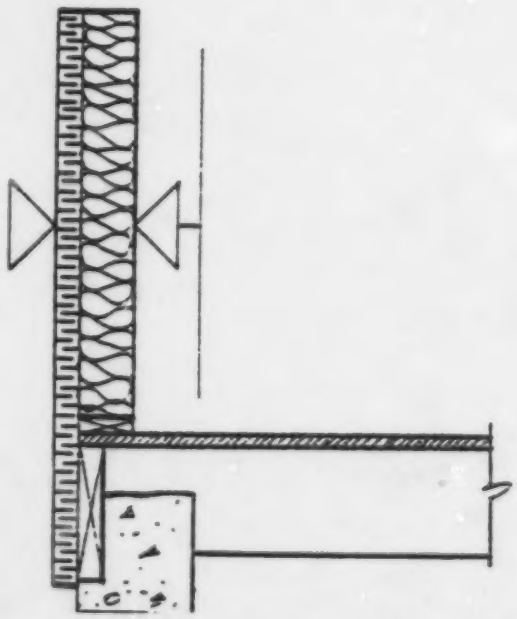
SYSTEM: 38x89 (2x4) @ 400 mm (16") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL | | |
|---|---|---|---|
| | RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
| GROSS COST: | $1495.46 | $1153.98 | m |
| | 127.50 | 112.50 | l |
| | $1622.96 | $1266.48 | |
| LESS SAVINGS: | $ 590.64 | $ 590.64 | m |
| | 6.00 | 6.00 | l |
| | $ 596.64 | $ 596.64 | |
| NET COST: | $ 904.82 | $ 563.34 | m |
| | 121.50 | 106.50 | l |
| | $1026.32 | $ 669.84 | |
| NET UNIT INCREMENTAL COST: | 10.65 | 6.89 | $/m² |
| | 0.99 | 0.64 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | 4 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.87 (R-22.0) | | |



NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

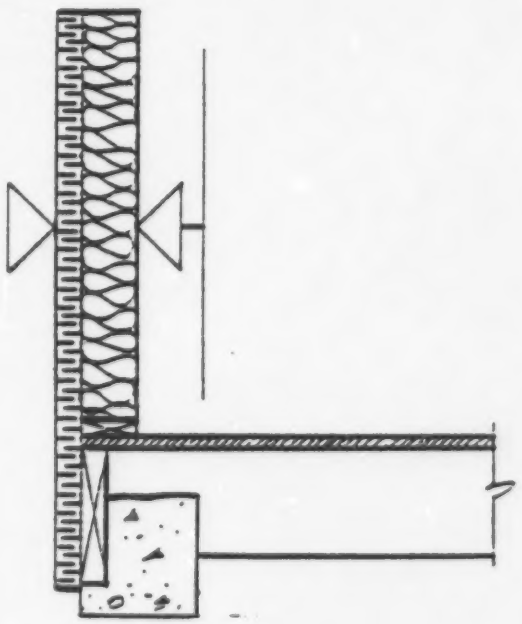
SYSTEM: 38x89 (2x4) @ 600 mm (24") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1155.36 | $ 813.88 | m |
| | 116.25 | 101.25 | l |
| | $1271.61 | $ 915.13 | |
| LESS SAVINGS: | $ 545.18 | $ 545.18 | m |
| | 6.00 | 6.00 | l |
| | $ 551.18 | $ 551.18 | |
| NET COST: | $ 610.18 | $ 268.70 | m |
| | 110.25 | 95.25 | l |
| | $ 720.43 | $ 363.95 | |
| NET UNIT INCREMENTAL COST: | 7.42 | 3.77 | $/m² |
| | 0.69 | 0.35 | $/ft² |
| COST PERFORMANCE INDEX: | 25 | -2 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.43 (R-19.5) | | |



NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

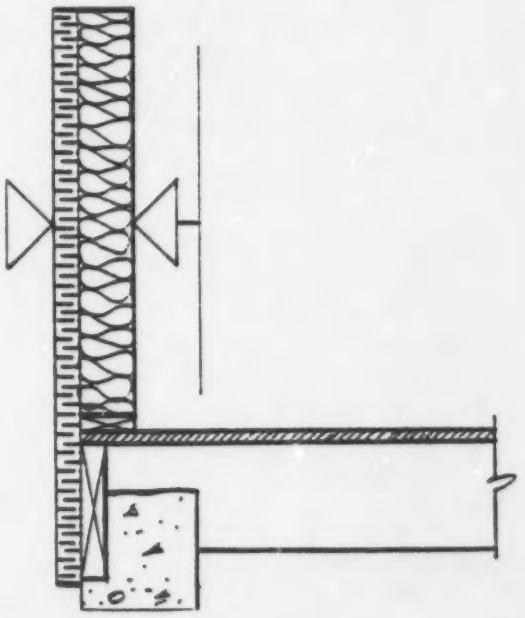
SYSTEM: 38x89 (2x4) @ 600 mm (24") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1378.18 | $1036.70 | m |
| | 105.00 | 90.00 | l |
| | $1483.18 | $1126.70 | |
| LESS SAVINGS: | $ 545.18 | $ 545.18 | m |
| | 6.00 | 6.00 | l |
| | $ 551.18 | $ 551.18 | |
| NET COST: | $ 833.00 | $ 491.52 | m |
| | 99.00 | 84.00 | l |
| | $ 932.00 | $ 575.52 | |
| NET UNIT INCREMENTAL COST: | 9.68 | 5.92 | $/m² |
| | 0.90 | 0.55 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | 4 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.87 (R-22.0) | | |



NOTES:
1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

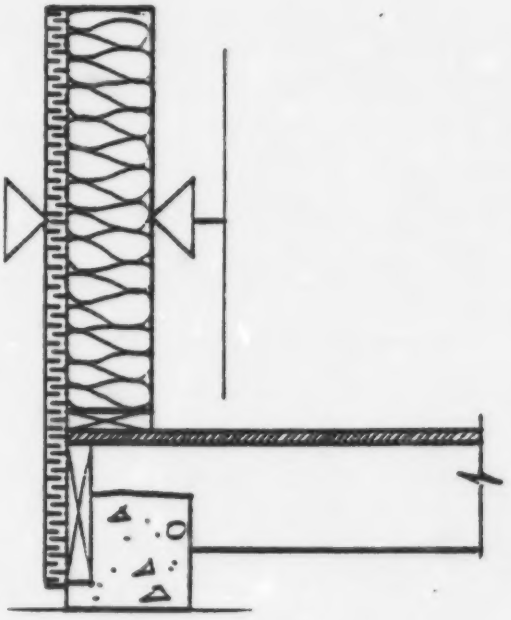
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1296.34 | $ 954.86 | m |
| | 165.00 | 150.00 | l |
| | $1461.34 | $1104.86 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $1008.33 | $ 666.85 | m |
| | 165.00 | 150.00 | l |
| | $1173.33 | $ 816.85 | |
| NET UNIT INCREMENTAL COST: | 12.16 | 8.50 | $/m² |
| | 1.13 | 0.79 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | 9 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.84 (R-27.5) | | |



NOTES:
1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.

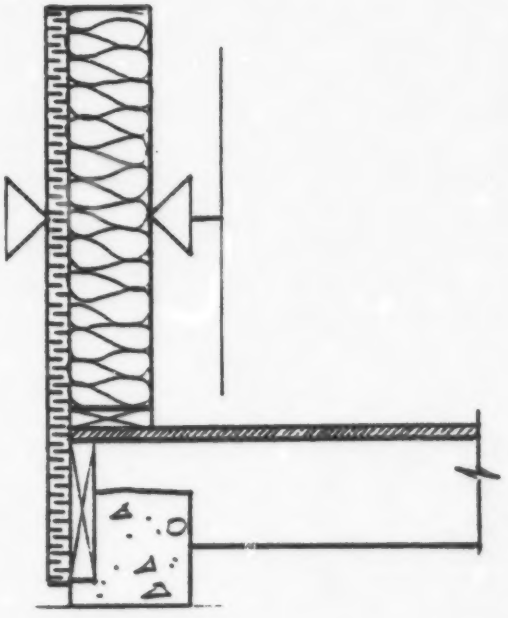
SYSTEM: 38x140 (2x6) @ 400 mm (16") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1549.90 | $1208.42 | m |
| | 180.00 | 165.00 | l |
| | $1729.90 | $1373.42 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $1261.89 | $ 920.41 | m |
| | 180.00 | 165.00 | l |
| | $1441.89 | $1085.41 | |
| NET UNIT INCREMENTAL COST: | 14.96 | 11.19 | $/m² |
| | 1.39 | 1.04 | $/ft² |
| COST PERFORMANCE INDEX: | 19 | 8 | |
| UPGRADED THERMAL RESISTANCE: | RSI 5.28 (R-30.0) | | |



NOTES:
1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost $173.94.
2. Insulated area includes headers.

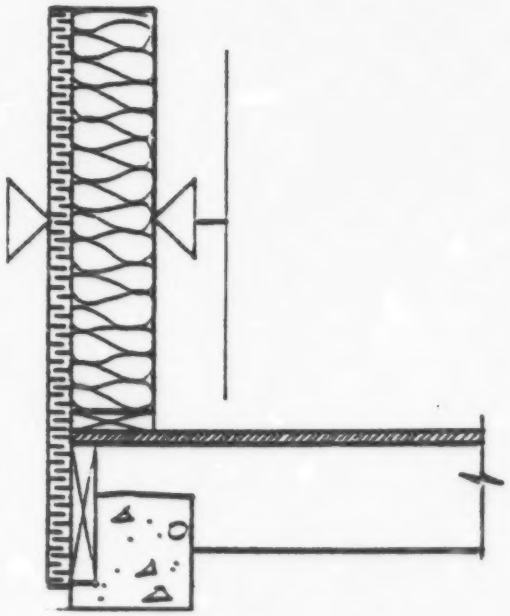
SYSTEM: 38x140 (2x6) @ 600 mm (24") with 38 mm (1½") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 25 mm (1") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1179.06 | $ 837.58 | m |
| | 142.50 | 127.50 | l |
| | $1321.56 | $ 965.08 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $ 891.05 | $ 549.57 | m |
| | 142.50 | 127.50 | l |
| | $1033.55 | $ 677.07 | |
| NET UNIT INCREMENTAL COST: | 10.65 | 6.99 | $/m² |
| | 0.99 | 0.65 | $/ft² |
| COST PERFORMANCE INDEX: | 25 | 11 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.84 (R-27.5) | | |



NOTES:
1. Alternate: use 189 mm (7 7/16") window jambs instead of exterior returns, net additional cost $48.77.
2. Insulated area includes headers.

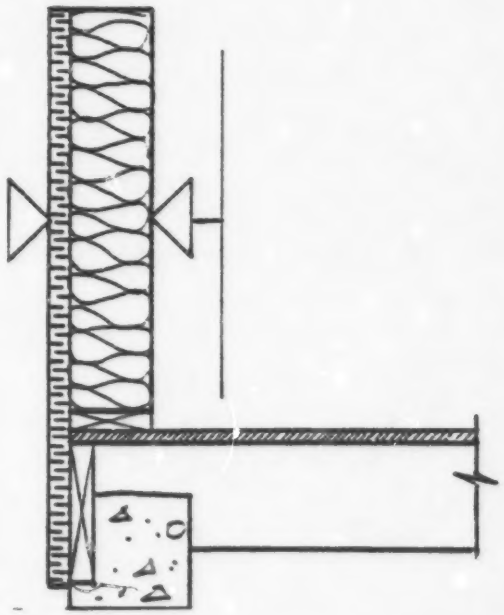
SYSTEM: 38x140 (2x6) @ 600 mm (24") with 51 mm (2") exterior extruded polystyrene insulated sheathing, corner bracing

CHANGES FROM CONVENTIONAL PRACTICE:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Use 163 mm (6 7/16") door and window jambs
- o Additional changes as per 38x140 (2x6) description

CONVENTIONAL - 38x140 (2x6)
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Add insulated sheathing
- o Add exterior returns to windows
- o Add 38 mm (1½") jamb extensions to doors
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1432.62 | $1091.14 | m |
| | 157.50 | 142.50 | l |
| | $1590.12 | $1233.64 | |
| LESS SAVINGS: | $ 288.01 | $ 288.01 | m |
| | 0 | 0 | l |
| | $ 288.01 | $ 288.01 | |
| NET COST: | $1144.61 | $ 803.13 | m |
| | 157.50 | 142.50 | l |
| | $1302.11 | $ 945.63 | |
| NET UNIT INCREMENTAL COST: | 13.45 | 9.79 | $/m² |
| | 1.25 | 0.91 | $/ft² |
| COST PERFORMANCE INDEX: | 21 | 10 | |
| UPGRADED THERMAL RESISTANCE: | RSI 5.28 (R-30.0) | | |



NOTES:
1. Alternate: use 202 mm (7 15/16") window jambs instead of exterior returns, net additional cost $173.94.
2. Insulated area includes headers.

SYSTEM: 38x89 (2x4) @ 400 mm (16") with 51 mm (2") exterior extruded polystyrene insulated sheathing, fibreboard sheathing

CHANGES FROM CONVENTIONAL PRACTICE:

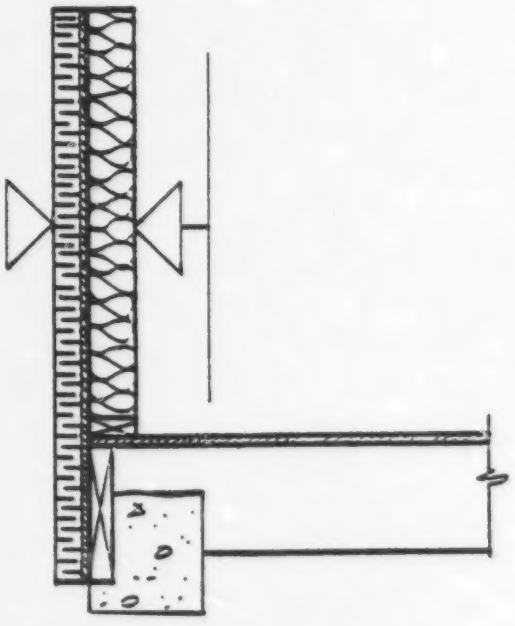
CONVENTIONAL - 38x89 (2x4)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings
- o Use 163 mm (6 7/16") door and window jambs
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing

CONVENTIONAL - 38x140 (2x6)

- o Decrease stud spacing from 600 mm (24") to 400 mm (16") O.C.
- o Add let-in 19x89 (1x4) corner bracing
- o Add extra corner studs to build out wall
- o Build out door and window rough openings (see note 1)
- o Cantilever gable end trusses
- o Delete 16 mm (5/8") fibreboard sheathing
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1482.26 | $1140.78 | m |
| | 157.50 | 142.50 | l |
| | $1639.76 | $1283.28 | |
| LESS SAVINGS: | $ 309.26 | $ 309.26 | m |
| | 0 | 0 | l |
| | $ 309.26 | $ 309.26 | |
| NET COST: | $1173.00 | $ 831.52 | m |
| | 157.50 | 142.50 | l |
| | $1330.50 | $ 974.02 | |
| NET UNIT | 13.77 | 10.11 | $/m² |
| INCREMENTAL COST: | 1.28 | 0.94 | $/ft² |
| COST PERFORMANCE INDEX: | 16 | 3 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.87 (R-22.0) | | |



NOTES:

1. Assumes 163 mm (6 7/16") jambs for doors and windows with no exterior returns.
2. Insulated area includes headers.

WALLS W-3(a)

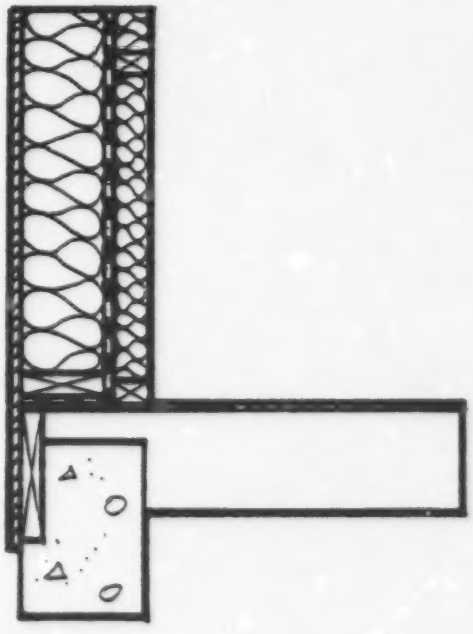
SYSTEM: 38x89 (2x4) @ 600 mm (24") with 38x38 (2x2) strapping

CHANGES FROM CONVENTIONAL:

CONVENTIONAL - 38x89 (2x4)
- o Add 38x64 (2x2) horizontal strapping and RSI 0.88 (R-5)
- o Add 38 mm (1½") door and window jamb extensions

CONVENTIONAL - 38x140 (2x6)
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)
- o Add 38x38 (2x2) horizontal strapping and RSI 0.88 (R-5)
- o Use 38 mm (1½") door and window jamb extensions

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $386.86 | $386.86 | m |
| | 288.00 | 288.00 | l |
| | $674.86 | $674.86 | |
| LESS SAVINGS: | $ 0 | $451.77 | m |
| | 0 | 0 | l |
| | $ 0 | $451.77 | |
| NET COST: | $386.86 | -$ 64.91 | m |
| | 288.00 | 288.00 | l |
| | $674.86 | $223.09 | |
| NET UNIT INCREMENTAL COST: | 6.99 | 2.31 | $/m² |
| | 0.65 | 0.21 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | -22 | |
| UPGRADED THERMAL RESISTANCE: | RSI 2.99 (R-17) | | |



NOTES:

WALLS W-3(b)

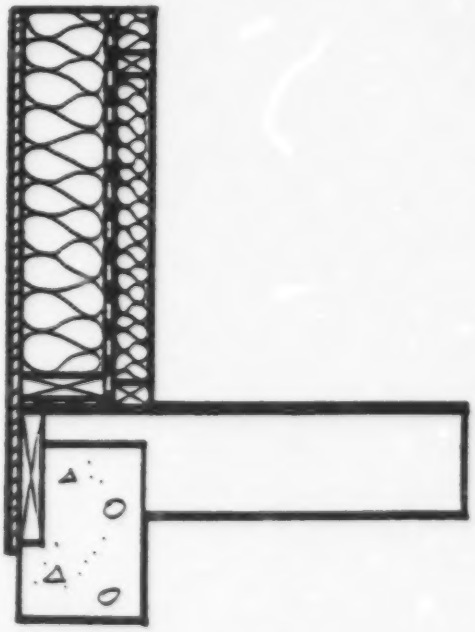
SYSTEM: 38x89 (2x4) @ 600 mm (24") with 38x64 (2x3) strapping

CHANGES FROM CONVENTIONAL:

CONVENTIONAL - 38x89 (2x4)
- o Add 38x64 (2x3) horizontal strapping and RSI 1.59 (R-9)
- o Add 64 mm (2½") door and window jamb extensions

CONVENTIONAL - 38x140 (2x6)
- o Replace 38x140 (2x6) studs with 38x89 (2x4)
- o Replace RSI 3.52 (R-20) batts with RSI 2.11 (R-12)
- o Add 38x64 (2x3) horizontal strapping and RSI 1.59 (R-9)
- o Use 64 mm (2½") door and window jamb extensions

| | CONVENTIONAL WALL RSI 2.11 (R-12) | RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $576.19 | $576.19 | m |
| | 288.00 | 288.00 | l |
| | $864.19 | $864.19 | |
| LESS SAVINGS: | $ 0 | $451.77 | m |
| | 0 | 0 | l |
| | $ 0 | $451.77 | |
| NET COST: | $576.19 | $124.42 | m |
| | 288.00 | 288.00 | l |
| | $864.19 | $412.42 | |
| NET UNIT INCREMENTAL COST: | 8.95 0.83 | 4.27 0.40 | $/m² $/ft² |
| COST PERFORMANCE INDEX: | 23 | 3 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.70 (R-21) | | |



NOTES:

SYSTEM: 38x140 (2x6) @ 600 mm (24") with 38x38 (2x2) strapping

CHANGES FROM CONVENTIONAL:

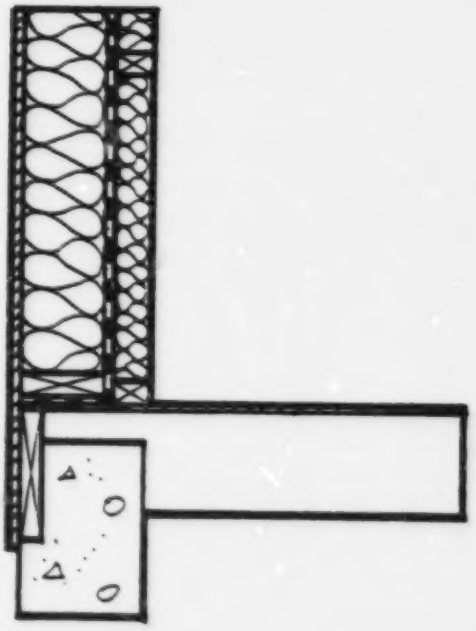
CONVENTIONAL - 38x89 (2x4)

- Replace 38x89 (2x4) studs with 38x140 (2x6)
- Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- Add 38x38 (2x2) horizontal strapping and RSI 0.88 (R-5)
- Add 89 mm (3½") door and window jamb extensions

CONVENTIONAL - 38x140 (2x6)

- Add 38x38 (2x2) horizontal strapping and RSI 0.88 (R-5)
- Add 38 mm (1½") door and window jamb extensions

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $838.63 | $386.86 | m |
| | 288.00 | 288.00 | l |
| | $1126.63 | $674.86 | |
| LESS SAVINGS: | $ 0 | $ 0 | m |
| | 0 | 0 | l |
| | $ 0 | $ 0 | |
| NET COST: | $838.63 | $386.86 | m |
| | 288.00 | 288.00 | l |
| | $1126.63 | $674.86 | |
| NET UNIT | 11.67 | 6.99 | $/m² |
| INCREMENTAL COST: | 1.08 | 0.65 | $/ft² |
| COST PERFORMANCE INDEX: | 21 | 8 | |



UPGRADED THERMAL RESISTANCE: RSI 4.40 (R-25)

NOTES:

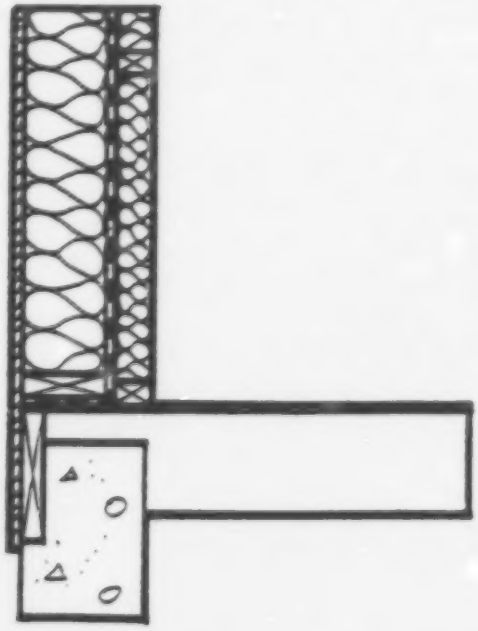
SYSTEM: 38x140 (2x6) @ 600 mm (24") with 38x64 (2x3) strapping

CHANGES FROM CONVENTIONAL:

CONVENTIONAL - 38x89 (2x4)
- o Replace 38x89 (2x4) studs with 38x140 (2x6)
- o Replace RSI 2.11 (R-12) batts with RSI 3.52 (R-20)
- o Add 38x64 (2x3) horizontal strapping and RSI 1.59 (R-9)
- o Add 114 mm (4½") door and window jamb extensions

CONVENTIONAL - 38x140 (2x6)
- o Add 38x64 (2x3) horizontal strapping and RSI 1.59 (R-9)
- o Add 64 mm (2½") door and window jamb extensions

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $1027.96 | $576.19 | m |
| | 288.00 | 288.00 | l |
| | $1315.96 | $864.19 | |
| LESS SAVINGS: | $ 0 | $ 0 | m |
| | 0 | 0 | l |
| | $ 0 | $ 0 | |
| NET COST: | $1027.96 | $576.19 | m |
| | 288.00 | 288.00 | l |
| | $1315.96 | $864.19 | |
| NET UNIT | 13.63 | 8.95 | $/m² |
| INCREMENTAL COST: | 1.27 | 0.83 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | 10 | |



UPGRADED THERMAL RESISTANCE: RSI 5.11 (R-29)

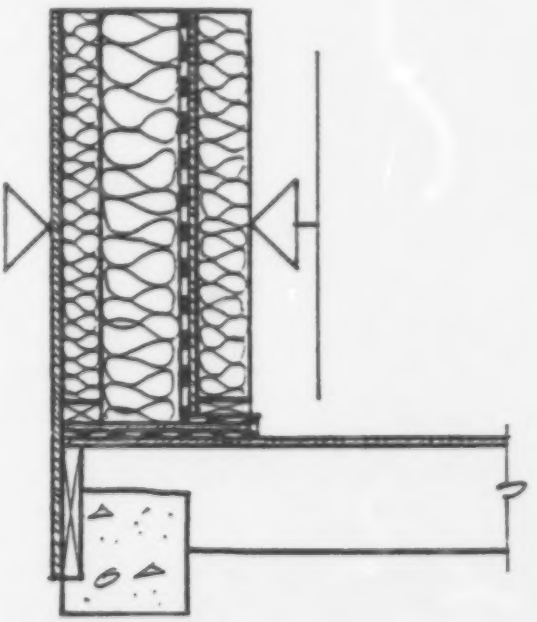
NOTES:

SYSTEM: Double wall

CHANGES FROM CONVENTIONAL PRACTICE,
FOR BOTH CONVENTIONAL WALL SYSTEMS:

- o Add outer 38x64 (2x3) wall c/w 11 mm (7/16") fibreboard sheathing
- o Add RSI 3.52 (R-20) batt insulation between inner and outer walls
- o Replace 4 mil poly with well sealed 6 mil
- o Add 16 mm (5/8") aspenite top and bottom plates
- o Use interior wood returns on all doors and windows
- o Extend trusses and roof 300 mm (1') in each dimension
- o Extend foundation by 300 mm (1') in each dimension
- o Extend floor joists and beam by 300 mm (1')
- o Additional stucco/siding to each dimension
- o Replace studs with 38x89 (2x4) @ 400 mm (16") O.C. to form inner wall

| | CONVENTIONAL WALL RSI 2.11 (R-12) | CONVENTIONAL WALL RSI 3.52 (R-20) | |
|---|---|---|---|
| GROSS COST: | $2478.92 | $2137.44 | m |
| | 985.00 | 970.00 | l |
| | $3463.92 | $3107.44 | |
| LESS SAVINGS: | $ 37.21 | $ 37.21 | m |
| | 0 | 0 | l |
| | $ 37.21 | $ 37.21 | |
| NET COST: | $2441.71 | $2100.23 | m |
| | 985.00 | 970.00 | l |
| | $3426.71 | $3020.23 | |
| NET UNIT INCREMENTAL COST: | 38.52 | 34.54 | $/m² |
| | 3.58 | 3.21 | $/ft² |
| COST PERFORMANCE INDEX: | 9 | 4 | |
| UPGRADED THERMAL RESISTANCE: | RSI 7.04 (R-40.0) | | |



NOTES:
1. Insulated area does not include headers.
2. Cost includes airtightness sealing of main walls, windows and doors.
3. Requires additional manpower or mechanical aids to raise walls.

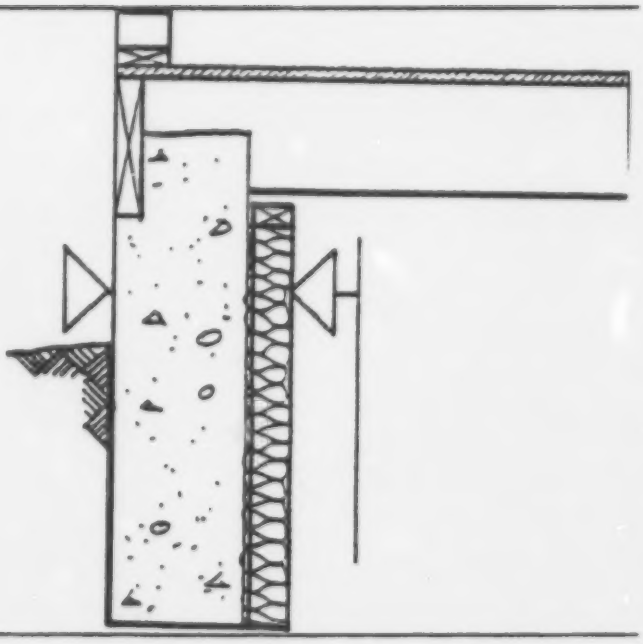
SYSTEM: RSI 2.11 (R-12.0) interior glass fibre batts, 38x64 (2x3) framing

CHANGES FROM CONVENTIONAL PRACTICE:

- Replace RSI 1.76 (R-10.0) batts with RSI 2.11 (R-12.0)

| | | |
|---|---|---|
| GROSS COST: | $37.28 | m |
| | 0 | 1 |
| | $37.28 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $37.28 | m |
| | 0 | 1 |
| | $37.28 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 0.43 | $/m² |
| | 0.04 | $/ft² |
| COST PERFORMANCE INDEX: | 219 | |
| UPGRADED THERMAL RESISTANCE: | RSI 2.11 (R-12.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

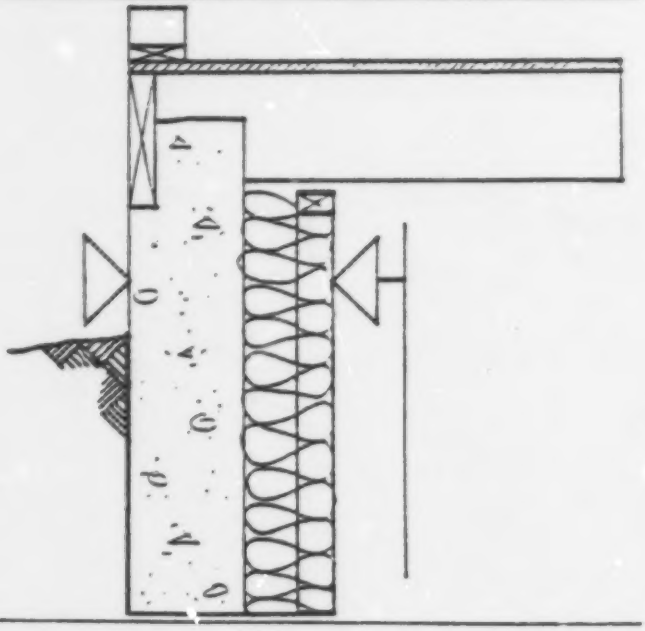
SYSTEM: RSI 3.52 (R-20.0) interior glass fibre batts, 38x64 (2x3) framing

CHANGES FROM CONVENTIONAL PRACTICE:

- Replace RSI 1.76 (R-10.0) batts with RSI 3.52 (R-20.0)

| | | |
|---|---|---|
| GROSS COST: | $186.40 | m |
| | 12.00 | l |
| | $198.40 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $186.40 | m |
| | 12.00 | l |
| | $198.40 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 2.29 | $/m² |
| | 0.21 | $/ft² |
| COST PERFORMANCE INDEX: | 124 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.52 (R-20.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

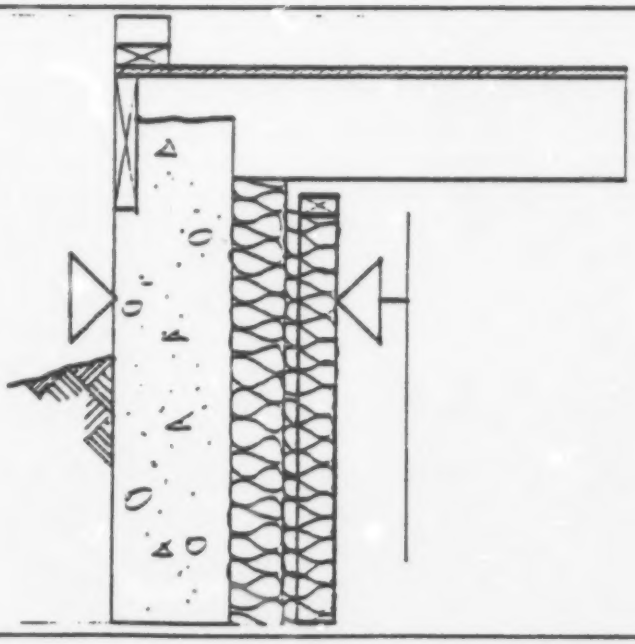
SYSTEM: RSI 4.23 (R-24.0) interior glass fibre batts, 38x64 (2x3) framing

CHANGES FROM CONVENTIONAL PRACTICE:

- o Replace RSI 1.76 (R-10.0) batts with RSI 2.11 (R-12.0) vertical and RSI 2.11 (R-12.0) horizontal

| | | |
|---|---|---|
| GROSS COST: | $260.96 | m |
| | 36.00 | l |
| | $296.96 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $260.96 | m |
| | 36.00 | l |
| | $296.96 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 3.43 | $/m² |
| | 0.32 | $/ft² |
| COST PERFORMANCE INDEX: | 97 | |
| UPGRADED THERMAL RESISTANCE: | RSI 4.23 (R-24.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

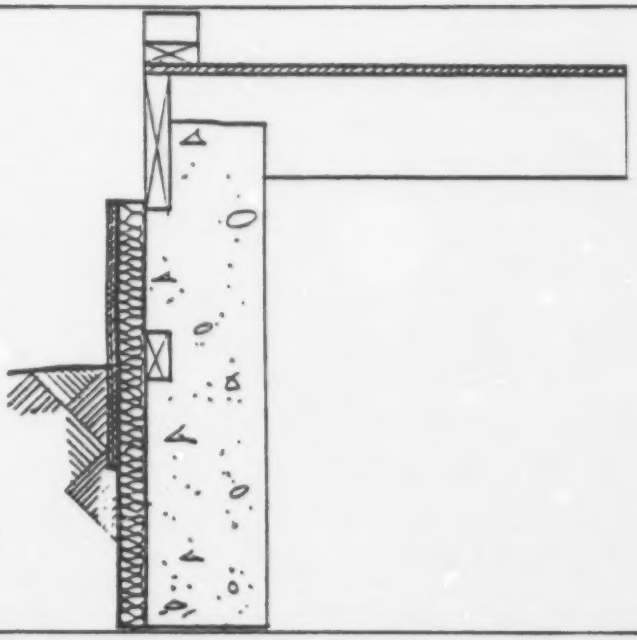
SYSTEM: 51 mm (2") exterior rigid glass fibre insulation, interior unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Cover insulation to 150 mm (6") B/G with 13 mm (½") P/T plywood
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1115.06 | m |
| | 172.50 | l |
| | $1287.56 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $ 726.25 | m |
| | 51.50 | l |
| | $ 777.75 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 8.98 | $/m² |
| | 0.83 | $/ft² |
| COST PERFORMANCE INDEX: | -11 | |
| UPGRADED THERMAL RESISTANCE: | RSI 1.50 (R-8.5) | |



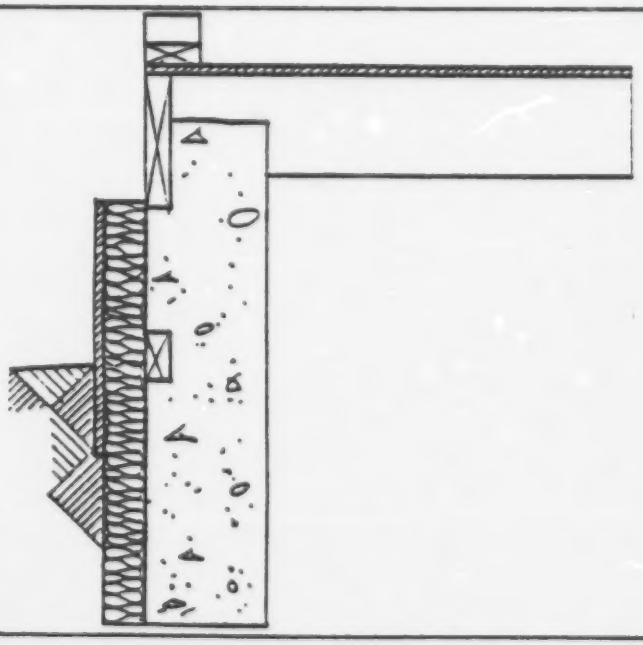
NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

SYSTEM: 76 mm (3") exterior rigid glass fibre insulation, interior unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 76 mm (3") insulation to footing level
- o Cover insulation to 150 mm (6") B/G with 13 mm (½") P/T plywood
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1439.61 | m |
| | 187.50 | l |
| | $1627.11 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $1050.80 | m |
| | 66.50 | l |
| | $1117.30 | |
| NET UNIT INCREMENTAL COST: | 12.90 | $/m² |
| | 1.20 | $/ft² |
| COST PERFORMANCE INDEX: | 11 | |
| UPGRADED THERMAL RESISTANCE: | RSI 2.38 (R-13.5) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

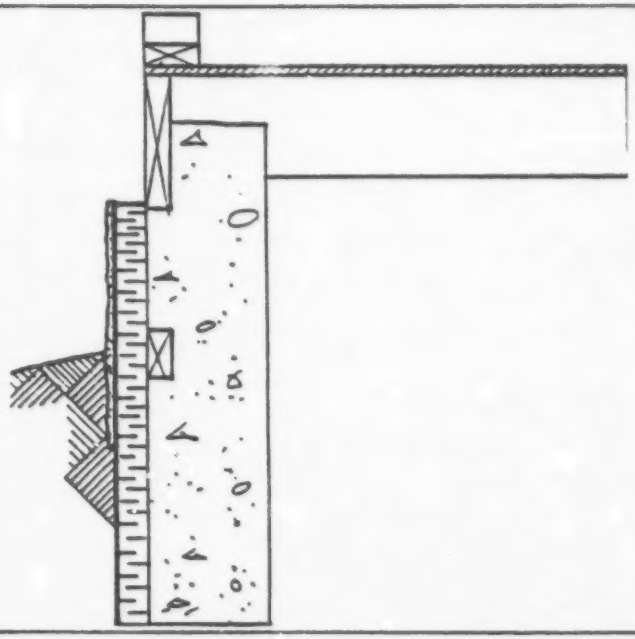
SYSTEM: 51 mm (2") exterior extruded polystyrene insulation, basement unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1220.27 | m |
| | 172.50 | l |
| | $1392.77 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $ 831.46 | m |
| | 51.50 | l |
| | $ 882.96 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 10.19 | $/m² |
| | 0.95 | $/ft² |
| COST PERFORMANCE INDEX: | 0 | |
| UPGRADED THERMAL RESISTANCE: | RSI 1.76 (R-10.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

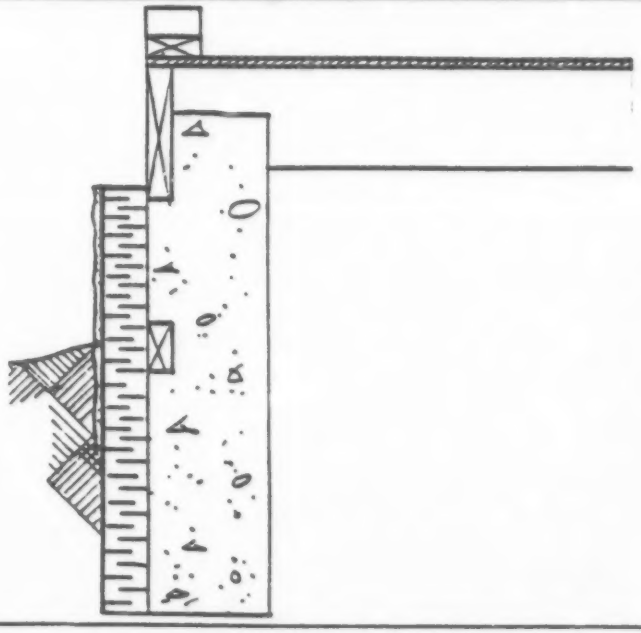
SYSTEM: 76 mm (3") exterior extruded polystyrene insulation, basement unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 76 mm (3") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1660.15 | m |
| | 187.50 | l |
| | $1847.65 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $1271.34 | m |
| | 66.50 | l |
| | $1337.84 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 15.45 | $/m² |
| | 1.44 | $/ft² |
| COST PERFORMANCE INDEX: | 12 | |
| UPGRADED THERMAL RESISTANCE: | RSI 2.64 (R-15.0) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

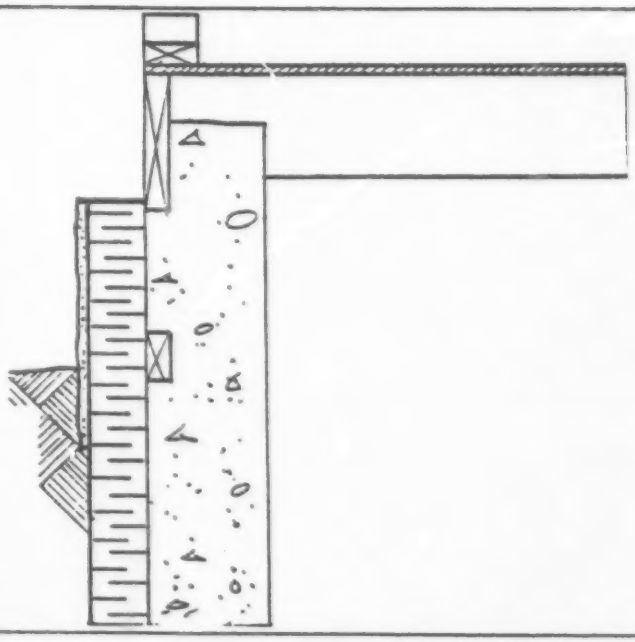
SYSTEM: 102 mm (4") exterior extruded polystyrene insulation, basement unfinished

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 102 mm (4") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete interior insulation, framing, poly
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1764.25 | m |
| | 217.50 | l |
| | $1981.75 | |
| LESS SAVINGS: | $ 388.81 | m |
| | 121.00 | l |
| | $ 509.81 | |
| NET COST: | $1375.44 | m |
| | 96.50 | l |
| | $1471.94 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 16.99 | $/m² |
| | 1.58 | $/ft² |
| COST PERFORMANCE INDEX: | 17 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.52 (R-20.0) | |



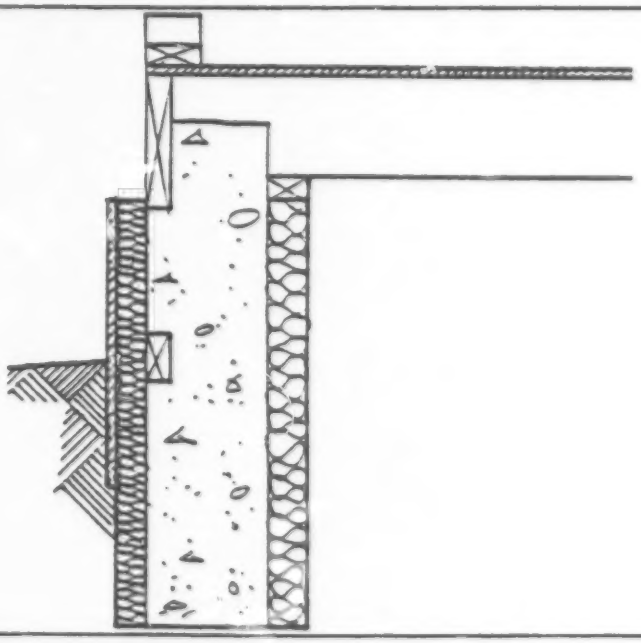
NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

SYSTEM: RSI 1.76 (R-10.0) interior glass fibre batts, 51 mm (2") exterior rigid glass fibre insulation

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Cover insulation to 150 mm (6") B/G with 13 mm (½") P/T plywood
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1115.06 | m |
| | 172.50 | l |
| | $1287.56 | |
| LESS SAVINGS: | $ 50.00 | m |
| | 25.00 | l |
| | $ 75.00 | |
| NET COST: | $1065.00 | m |
| | 147.50 | l |
| | $1212.56 | |
| NET UNIT INCREMENTAL COST: | 14.00 | $/m² |
| | 1.30 | $/ft² |
| COST PERFORMANCE INDEX: | 19 | |
| UPGRADED THERMAL RESISTANCE: | RSI 3.26 (R-18.5) | |



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

SYSTEM: RSI 1.76 (R-10.0) interior glass fibre batts, 51 mm (2") exterior extruded polystyrene insulation

CHANGES FROM CONVENTIONAL PRACTICE:

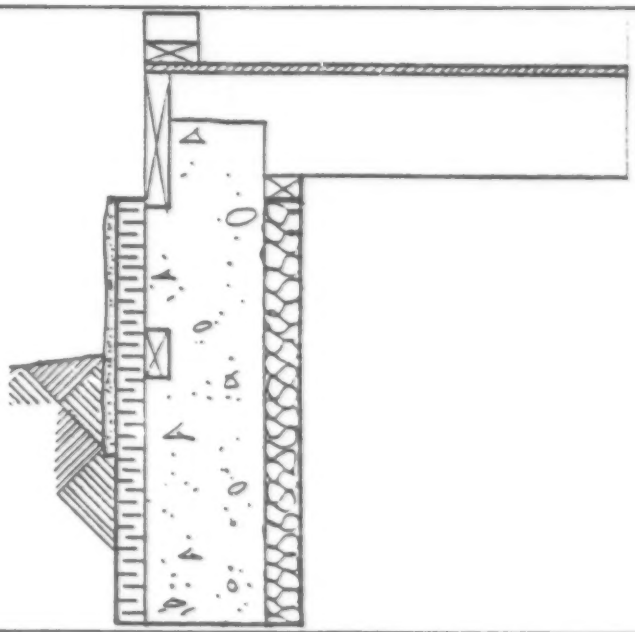
- o Cast-in-place P/T 38x89 (2x4) nailer at grade
- o Rough out door and window penetrations with P/T 38x89 (2x4)
- o Add 51 mm (2") insulation to footing level
- o Tape joints between sheets
- o Apply acrylic latex parging to 150 mm (6") B/G
- o Delete bituminous dampproofing

| | | |
|---|---|---|
| GROSS COST: | $1220.27 | m |
| | 172.50 | l |
| | $1392.77 | |
| LESS SAVINGS: | $ 50.00 | m |
| | 25.00 | l |
| | $ 75.00 | |
| NET COST: | $1170.27 | m |
| | 147.50 | l |
| | $1317.77 | |

NET UNIT INCREMENTAL COST: 15.21 $/m²
1.41 $/ft²

COST PERFORMANCE INDEX: 19

UPGRADED THERMAL RESISTANCE: RSI 3.52 (R-20.0)



NOTES:
1. Insulated area does not include headers.
2. RSI values do not include effect of soil.

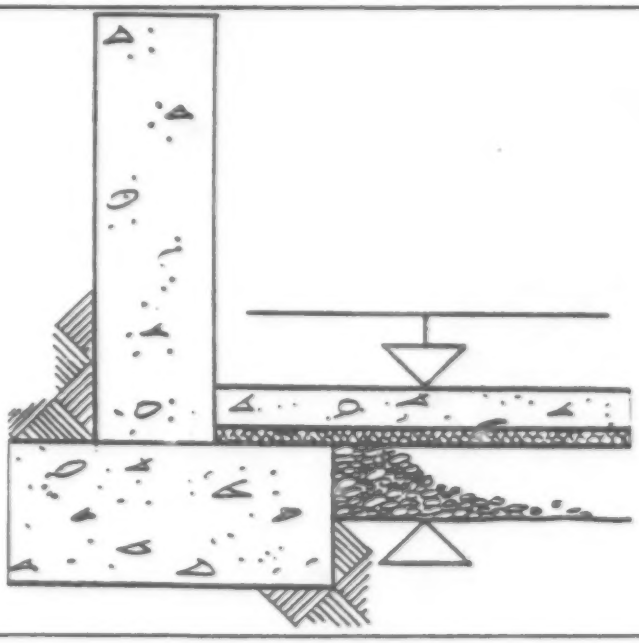
SYSTEM: Slab; 25 mm (1") rigid glass fibre insulation under slab

CHANGES FROM CONVENTIONAL PRACTICE:

- o Remove air barrier from insulation (see note 1)
- o Add 25 mm (1") insulation under slab

| | | |
|---|---|---|
| GROSS COST: | $ 353.23 | m |
| | 63.00 | l |
| | $ 416.23 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 353.23 | m |
| | 63.00 | l |
| | $ 416.23 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 4.69 | $/m² |
| | 0.44 | $/ft² |
| COST PERFORMANCE INDEX: | 881 | |
| UPGRADED THERMAL RESISTANCE: | RSI 0.97 (R-5.5) | |



NOTES:

1. Air barrier should be removed to prevent excessive cure time of concrete or water ponding within insulation.
2. Cost includes extra time to level small variations in pea gravel height.
3. RSI values include effect of concrete.
4. RSI values do not include effect of soil.

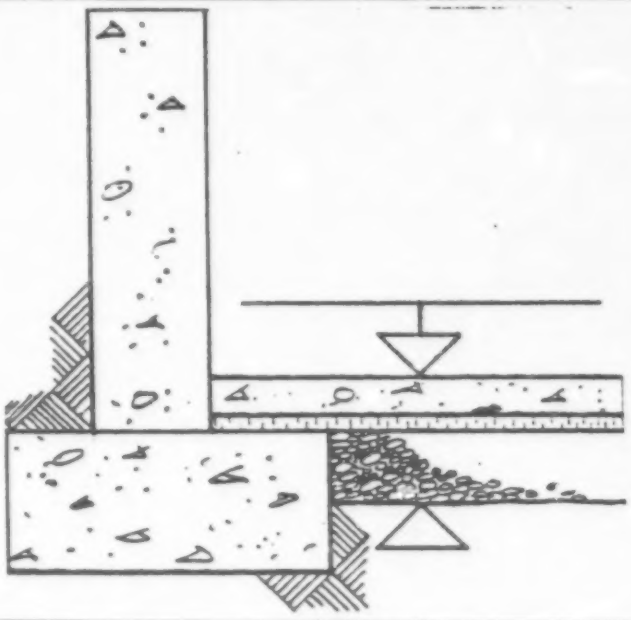
SYSTEM: Slab; 25 mm (1") extruded polystyrene under slab

CHANGES FROM CONVENTIONAL PRACTICE:

o Add 25 mm (1") insulation under slab

| | | |
|---|---|---|
| GROSS COST: | $ 419.40 | m |
| | 73.50 | l |
| | $ 492.50 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 419.40 | m |
| | 73.50 | l |
| | $ 492.50 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 5.55 | $/m² |
| | 0.52 | $/ft² |
| COST PERFORMANCE INDEX: | 762 | |
| UPGRADED THERMAL RESISTANCE: | RSI 1.07 (R-6.1) | |



NOTES:
1. Cost includes extra time to level small variations in pea gravel height.
2. RSI values include effect of concrete.
3. RSI values do not include effect of soil.

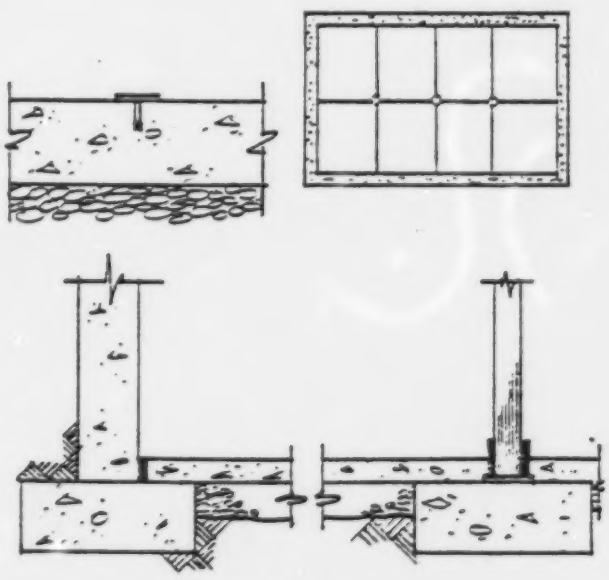
SYSTEM: Slab; crack initiators and isolators

CHANGES FROM CONVENTIONAL PRACTICE:

- o Cast-in crack initiators in approx. 3mx3m (10'x10') sections
- o Place 16 mm (5/8") fibreboard strip slip joint around perimeter of slab
- o Place slip joints around tele-posts

| | | |
|---|---|---|
| GROSS COST: | $ 45.97 | m |
| | 28.88 | l |
| | $ 74.85 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 45.97 | m |
| | 28.88 | l |
| | $ 74.85 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 0.84 | $/m² |
| | 0.08 | $/ft² |
| COST PERFORMANCE INDEX: | N/A | |
| UPGRADED THERMAL RESISTANCE: | N/A | |



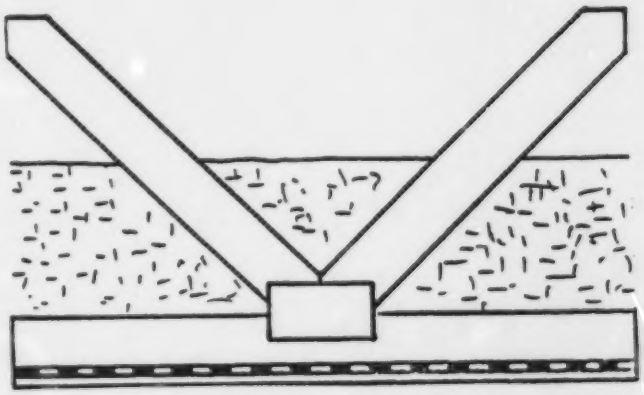
NOTES:
1. Assumes 2 man basement floor placer crew to install crack initiators.

SYSTEM: RSI 7.93 (R-45.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

- o Blow-in additional RSI 0.88 (R-5.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $66.82 | m 1 |
| | $66.82 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $66.82 | m 1 |
| | $66.82 | |
| NET UNIT INCREMENTAL COST: | 0.73 | $/m² |
| | 0.07 | $/ft² |
| COST PERFORMANCE INDEX: | 22 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

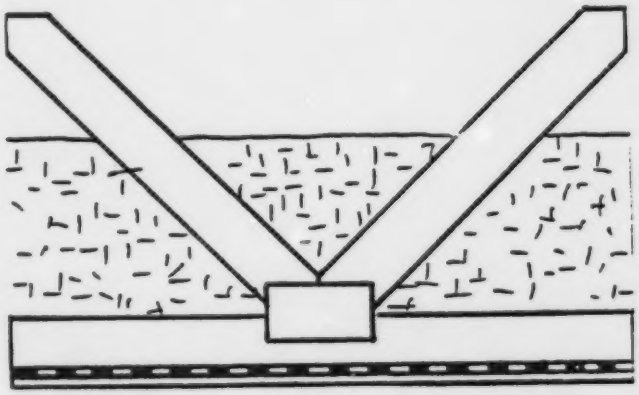
SYSTEM: RSI 8.81 (R-50.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

- o Blow in additional RSI 1.76 (R-10.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $133.64 | m 1 |
| | $133.64 | |
| LESS SAVINGS: | $ 0 | m 1 |
| | 0 | |
| | $ 0 | |
| NET COST: | $133.64 | m 1 |
| | $133.64 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 1.45 | $/m² |
| | 0.13 | $/ft² |
| COST PERFORMANCE INDEX: | 20 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

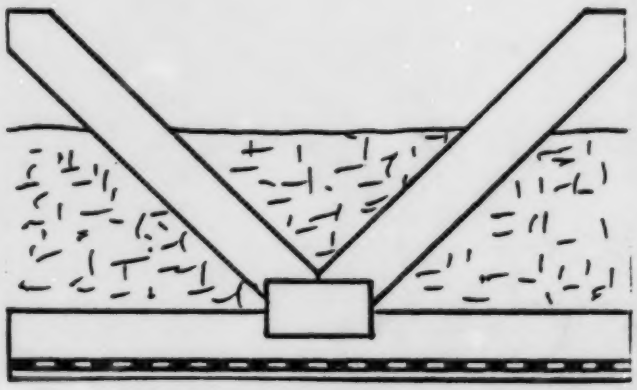
SYSTEM: RSI 9.69 (R-55.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

- o Blow in additional RSI 2.64 (R-15.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $200.46 | m 1 |
| | $200.46 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $200.46 | m 1 |
| | $200.46 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 2.18 | $/m² |
| | 0.20 | $/ft² |
| COST PERFORMANCE INDEX: | 18 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

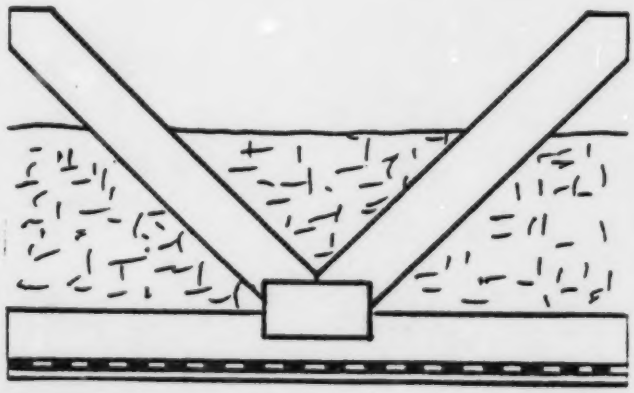
SYSTEM: RSI 10.57 (R-60.0) blown-in cellulose

CHANGES FROM CONVENTIONAL PRACTICE:

- o Blow in additional RSI 3.52 (R-20.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $267.28 | m 1 |
| | $267.28 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $267.28 | m 1 |
| | $267.28 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 2.91 | $/m² |
| | 0.27 | $/ft² |
| COST PERFORMANCE INDEX: | 16 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) blown-in cellulose.

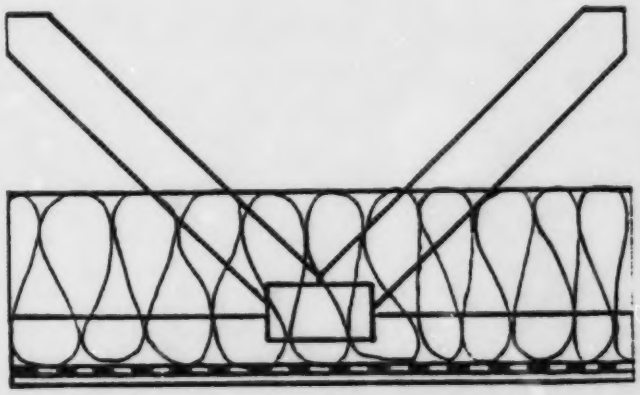
SYSTEM: RSI 7.93 (R-45.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

- Blow in additional RSI 0.88 (R-5.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $ 78.99 | m<br>l |
| | $ 78.99 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 78.99 | m<br>l |
| | $ 78.99 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 0.86<br>0.08 | $/m²<br>$/ft² |
| COST PERFORMANCE INDEX: | 19 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

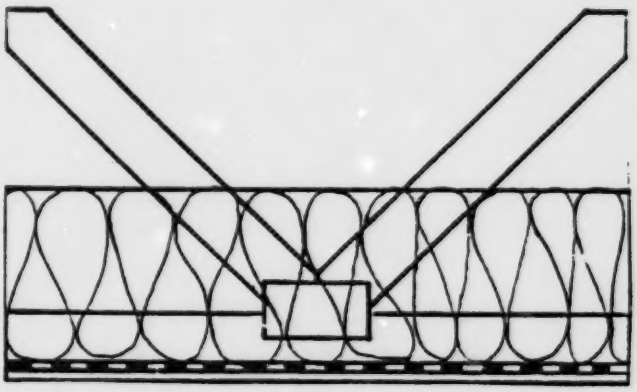
SYSTEM: RSI 8.81 (R-50.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

o Blow in additional RSI 1.76 (R-10.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $157.98 | m 1 |
| | $157.98 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $157.98 | m 1 |
| | $157.98 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 1.72 | $/m² |
| | 0.16 | $/ft² |
| COST PERFORMANCE INDEX: | 17 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

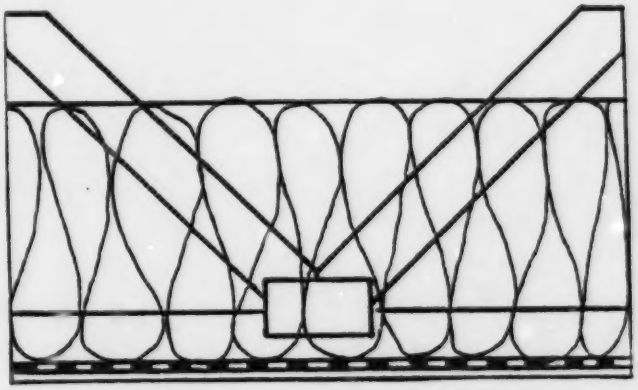
SYSTEM: RSI 9.69 (R-55.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

- Blow in additional RSI 2.64 (R-15.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $236.96 | m 1 |
| | $236.96 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | 1 |
| | $ 0 | |
| NET COST: | $236.96 | m 1 |
| | $236.96 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 2.57 | $/m² |
| | 0.24 | $/ft² |
| COST PERFORMANCE INDEX: | 15 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

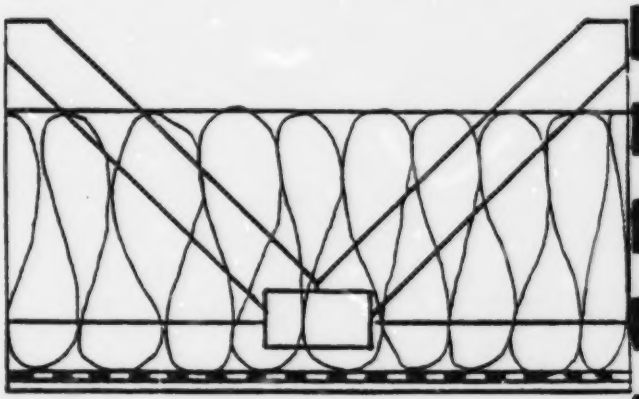
SYSTEM: RSI 10.57 (R-60.0) glass fibre blowing wool

CHANGES FROM CONVENTIONAL PRACTICE:

- o Blow in additional RSI 3.52 (R-20.0) insulation

| | | |
|---|---|---|
| GROSS COST: | $315.95 | m 1 |
| | $315.95 | |
| LESS SAVINGS: | $ 0 | m 1 |
| | 0 | |
| | $ 0 | |
| NET COST: | $315.95 | m 1 |
| | $315.95 | |

| | | |
|---|---|---|
| NET UNIT INCREMENTAL COST: | 3.43 | $/m² |
| | 0.32 | $/ft² |
| COST PERFORMANCE INDEX: | 14 | |



NOTES:

1. Conventional trusses used, thickness of insulation reduced at eaves.
2. Assumes conventional practice to be RSI 7.04 (R-40.0) glass fibre blowing wool.

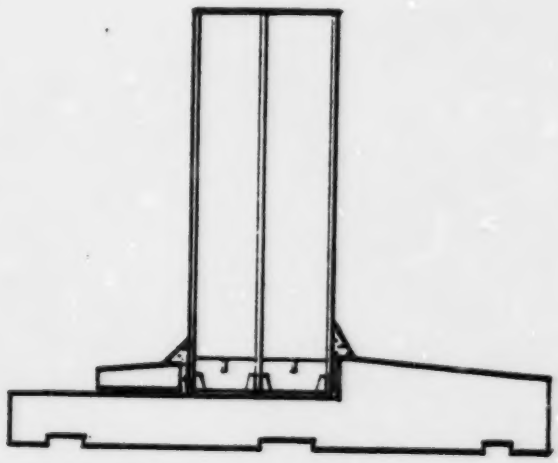
WINDOWS F-1(a)

SYSTEM: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

CONVENTIONAL WINDOW: Conventional double-glazing, metal spacer, 13 mm (½") air space

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.34 | 1.91 | 0.89 |
| UPGRADED SYSTEM: | 0.48 | 2.71 | 0.79 |

| | $ | $/m² | $/ft² |
|---|---|---|---|
| GROSS COST: | $2,032.28 | $184.53 | $17.15 |
| LESS SAVINGS: | 1,700.48 | 154.41 | 14.35 |
| NET COST: | 331.80 | 30.12 | 2.80 |



NOTES:

1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

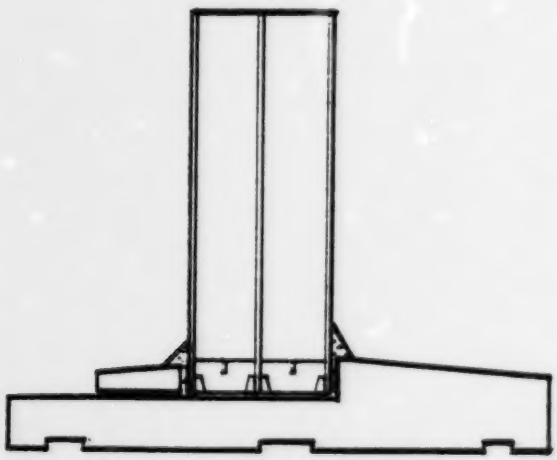
WINDOWS F-1(b)

SYSTEM: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

CONVENTIONAL WINDOW: Conventional double-glazing, metal spacer, 13 mm (½") air space

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.34 | 1.91 | 0.89 |
| UPGRADED SYSTEM: | 0.48 | 2.71 | 0.79 |

| | $ | $/m² | $/ft² |
|---|---|---|---|
| GROSS COST: | $2,488.50 | $225.96 | $21.00 |
| LESS SAVINGS: | 1,919.70 | 174.31 | 16.20 |
| NET COST: | 568.80 | 51.65 | 4.80 |



NOTES:

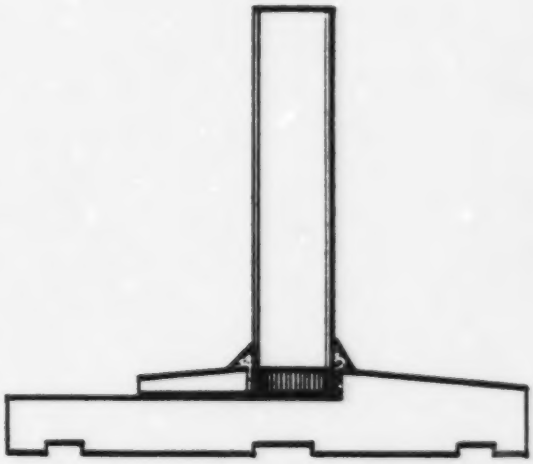
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: B

WINDOWS F-2

SYSTEM: Double-glazing, butyl/metal spacer, 13 mm (½") air space

CONVENTIONAL WINDOW: Conventional double-glazing, metal spacer, 13 mm (½") air space

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.34 | 1.91 | 0.89 |
| UPGRADED SYSTEM: | 0.34 | 1.95 | 0.91 |
| | $ | $/m$^2$ | $/ft$^2$ |
| GROSS COST: | $1,762.10 | $160.00 | $14.87 |
| LESS SAVINGS: | 1,700.48 | 154.41 | 14.35 |
| NET COST: | 61.62 | 5.59 | 0.52 |



NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

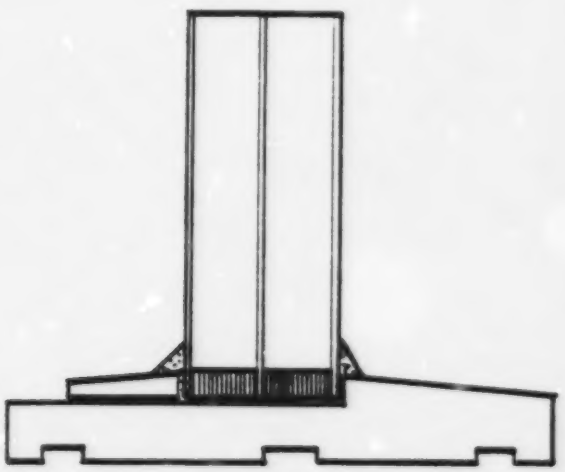
WINDOWS F-3

SYSTEM: Triple-glazing, butyl/metal spacers, 13 mm (½") air spaces

CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.51 | 2.92 | 0.82 |

| | $ | $/m$^2$ | $/ft$^2$ |
|---|---|---|---|
| GROSS COST: | $2,155.52 | $195.72 | $18.19 |
| LESS SAVINGS: | 2,032.28 | 184.53 | 17.15 |
| NET COST: | 123.24 | 11.19 | 1.04 |

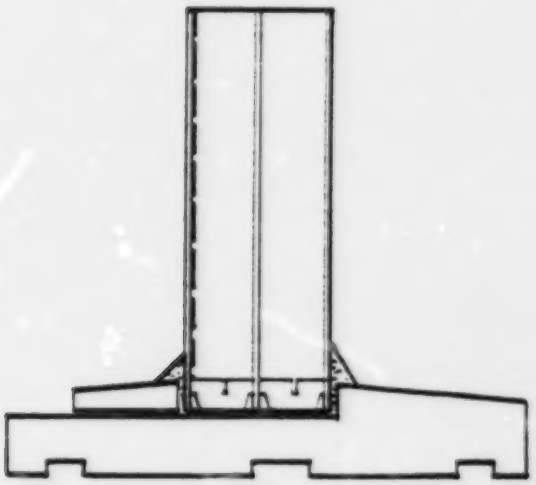


NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

SYSTEM: Triple-glazing, 1 low E film, metal spacers, 13 mm (½") air spaces

CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.60 | 3.40 | 0.68 |
| | $ | $/m$^2$ | $/ft$^2$ |
| GROSS COST: | $2,701.80 | $245.33 | $22.80 |
| LESS SAVINGS: | 2,488.50 | 225.96 | 21.00 |
| NET COST: | 213.30 | 19.37 | 1.80 |



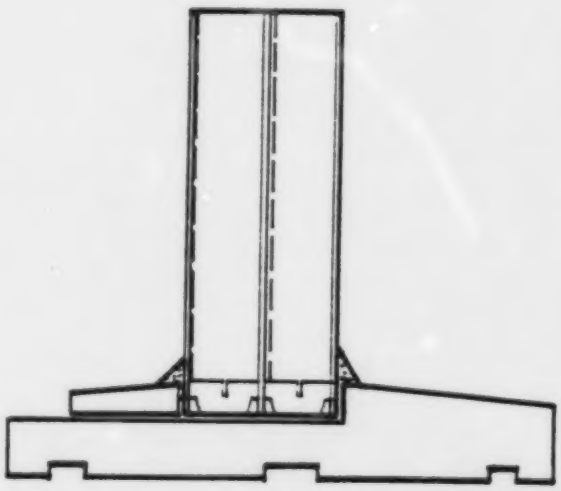
NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: C

SYSTEM: Triple-glazing, 2 low E films, metal spacers, 13 mm (½") air spaces

CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.69 | 3.94 | 0.59 |

| | $ | $/m² | $/ft² |
|---|---|---|---|
| GROSS COST: | $2,915.10 | $264.70 | $24.60 |
| LESS SAVINGS: | 2,488.50 | 225.96 | 21.00 |
| NET COST: | 426.60 | 38.74 | 3.60 |



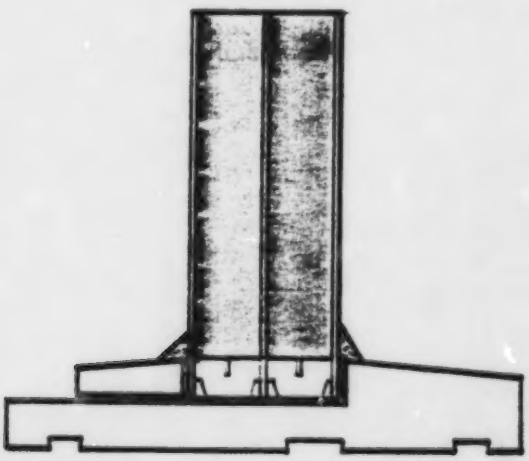
NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: C

SYSTEM: Triple-glazing, 1 low E film, metal spacers, 13 mm (½") argon spaces

CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.67 | 3.79 | 0.68 |

| | $ | $/m$^2$ | $/ft$^2$ |
|---|---|---|---|
| GROSS COST: | $2,566.71 | $233.06 | $21.66 |
| LESS SAVINGS: | 2,032.28 | 184.53 | 17.15 |
| NET COST: | 534.43 | 48.53 | 4.51 |



NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

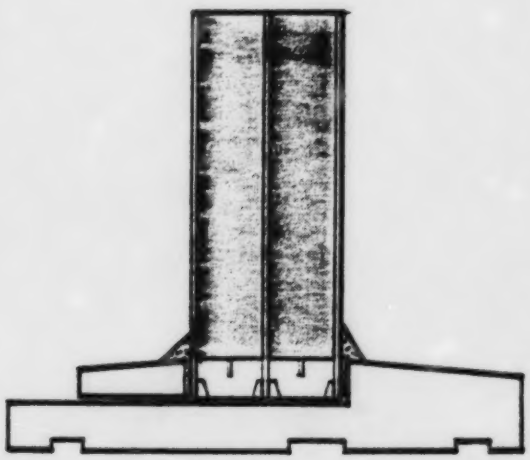
WINDOWS F-6(b)

SYSTEM: Triple-glazing, 1 low E film, metal spacers, 13 mm (½") argon spaces

CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.67 | 3.79 | 0.68 |

| | $ | $/m$^2$ | $/ft$^2$ |
|---|---|---|---|
| GROSS COST: | $3,021.75 | $274.38 | $25.50 |
| LESS SAVINGS: | 2,488.50 | 225.96 | 21.00 |
| NET COST: | 533.25 | 48.42 | 4.50 |



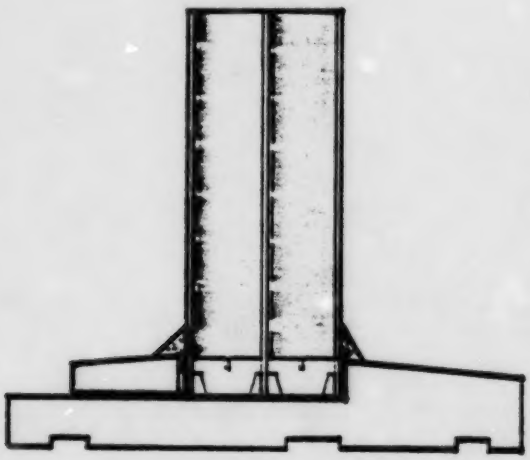
NOTES:

1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: C

| WINDOWS | | | F-7(a) |
|---|---|---|---|
| SYSTEM: Triple-glazing, 2 low E films, metal spacers, 13 mm (½") argon spaces | | | |
| CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces | | | |

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.79 | 4.46 | 0.59 |

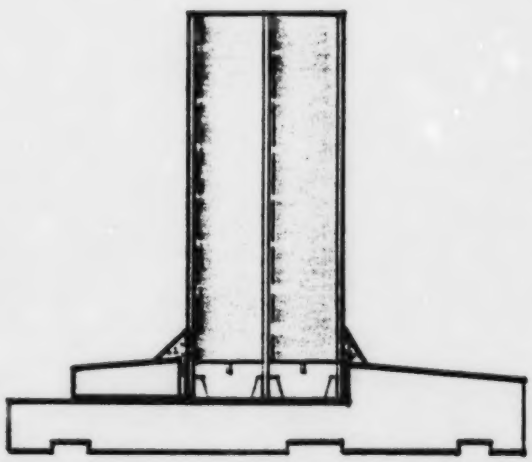
| | $ | $/m² | $/ft² |
|---|---|---|---|
| GROSS COST: | $3,101.15 | $281.59 | $26.17 |
| LESS SAVINGS: | 2,032.28 | 184.53 | 17.15 |
| NET COST: | 1,068.87 | 97.06 | 9.02 |



NOTES:

1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

| WINDOWS | | | F-7(b) |
|---|---|---|---|
| SYSTEM: Triple-glazing, 2 low E films, metal spacers, 13 mm (½") argon spaces | | | |
| CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces | | | |
| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.79 | 4.46 | 0.59 |
| | $ | $/m$^2$ | $/ft$^2$ |
| GROSS COST: | $3,128.40 | $284.06 | $26.40 |
| LESS SAVINGS: | 2,488.50 | 225.96 | 21.00 |
| NET COST: | 639.90 | 58.10 | 5.40 |



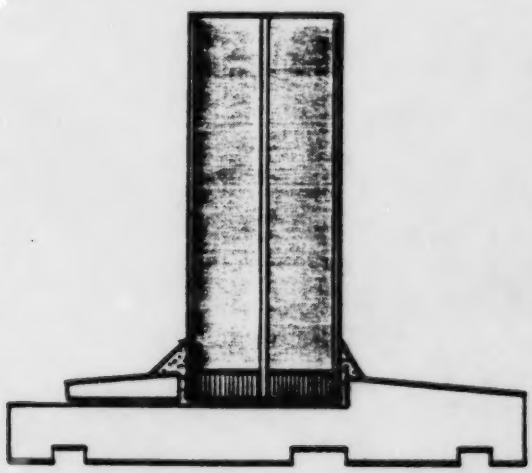
NOTES:

1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: C

SYSTEM: Triple-glazing, 1 low E film, butyl/metal spacers, 13 mm (½") argon spaces

CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.78 | 4.44 | 0.68 |
| | $ | $/m$^2$ | $/ft$^2$ |
| GROSS COST: | $2,689.95 | $244.25 | $22.70 |
| LESS SAVINGS: | 2,032.28 | 184.53 | 17.15 |
| NET COST: | 657.67 | 59.72 | 5.55 |



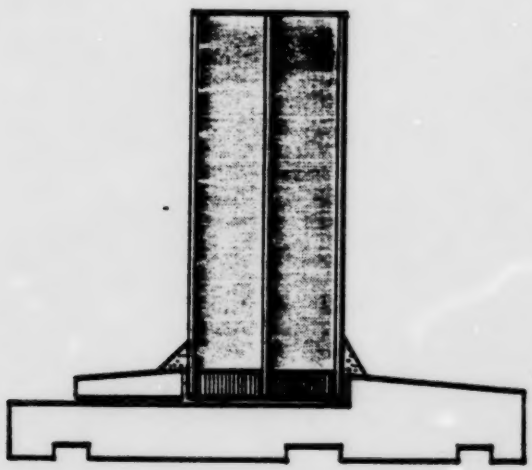
NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

SYSTEM: Triple-glazing, 2 low E films, butyl/metal spacers, 13 mm (½") argon spaces

CONVENTIONAL WINDOW: Conventional triple-glazing, metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.48 | 2.71 | 0.79 |
| UPGRADED SYSTEM: | 0.97 | 5.52 | 0.59 |

| | $ | $/m$^2$ | $/ft$^2$ |
|---|---|---|---|
| GROSS COST: | $3,224.39 | $292.78 | $27.21 |
| LESS SAVINGS: | 2,032.28 | 184.53 | 17.15 |
| NET COST: | 1,192.11 | 108.25 | 10.06 |



NOTES:

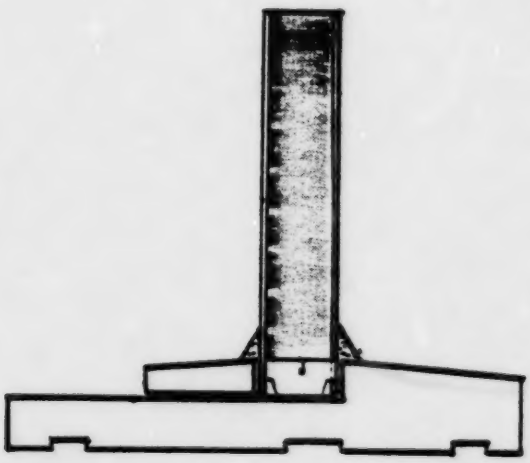
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

SYSTEM: Double-glazing, 1 low E film, metal spacer, 13 mm (½") argon space

CONVENTIONAL WINDOW: Conventional double-glazing, metal spacer, 13 mm (½") air space

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.34 | 1.91 | 0.89 |
| UPGRADED SYSTEM: | 0.55 | 3.12 | 0.75 |

| | $ | $/m² | $/ft² |
|---|---|---|---|
| GROSS COST: | $2,234.91 | $202.93 | $18.86 |
| LESS SAVINGS: | 1,700.48 | 154.41 | 14.35 |
| NET COST: | 534.43 | 48.52 | 4.51 |



NOTES:

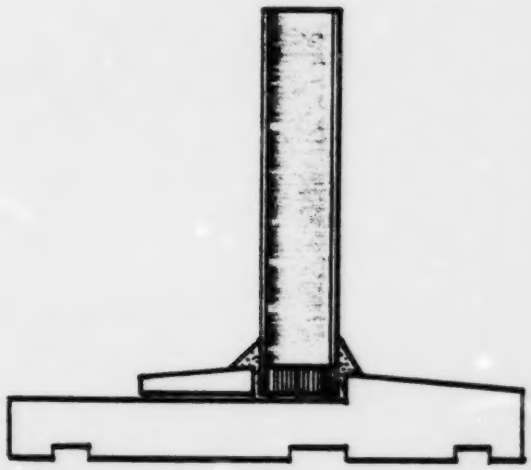
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

SYSTEM: Double-glazing, 1 low E film, butyl/metal spacer, 13 mm (½") argon space

CONVENTIONAL WINDOW: Conventional double-glazing, metal spacer, 13 mm (½") air space

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.34 | 1.91 | 0.89 |
| UPGRADED SYSTEM: | 0.61 | 3.46 | 0.75 |

| | $ | $/m² | $/ft² |
|---|---|---|---|
| GROSS COST: | $2,296.53 | $208.53 | $19.38 |
| LESS SAVINGS: | 1,700.48 | 154.41 | 14.35 |
| NET COST: | 596.05 | 54.12 | 5.03 |

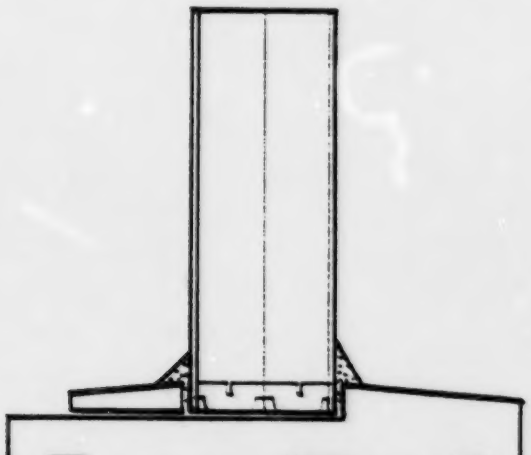


NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: A

SYSTEM: Triple-glazing, Heat Mirror 66, metal spacers, 13 mm (½") air spaces

CONVENTIONAL WINDOW: Triple-glazing, butyl/metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.51 | 2.92 | 0.82 |
| UPGRADED SYSTEM: | 0.60 | 3.41 | 0.46 |
| | $ | $/m$^2$ | $/ft$^2$ |
| GROSS COST: | $2,556.05 | $232.09 | $21.57 |
| LESS SAVINGS: | 2,021.61 | 183.57 | 17.06 |
| NET COST: | 534.44 | 48.52 | 4.51 |



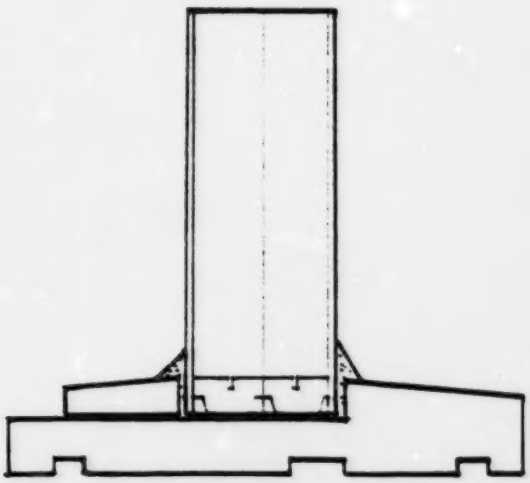
NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: B

SYSTEM: Triple-glazing, Heat Mirror 88 film, metal spacers, 13 mm (½") air spaces

CONVENTIONAL WINDOW: Triple-glazing, butyl/metal spacers, 13 mm (½") air spaces

| | THERMAL RESISTANCE RSI | (R) | SHADING COEFFICIENT |
|---|---|---|---|
| CONVENTIONAL: | 0.51 | 2.92 | 0.82 |
| UPGRADED SYSTEM: | 0.57 | 3.26 | 0.68 |

| | $ | $/m$^2$ | $/ft$^2$ |
|---|---|---|---|
| GROSS COST: | $2,508.65 | $227.79 | $21.17 |
| LESS SAVINGS: | 2,021.61 | 183.57 | 17.06 |
| NET COST: | 487.04 | 44.22 | 4.11 |



NOTES:
1. Unit area costs are based on glass dimensions.
2. Costs developed using data for non-operating wood windows with 163 mm (6 7/16" jambs), actual costs would vary with window type and jamb width.
3. Thermal resistance and shading coefficient values calculated assuming a 0.91 m x 1.22 m (3' x 4') wood window and an outdoor temperature of -18°C (0°F), indoor temperature of 21°C (70°F), wind speed of 6.7 m/s (15 mph) and no solar gains.
4. All costs developed using August 1990 data.
5. Manufacturer: B

AIRTIGHTNESS A-1

SYSTEM COMPONENTS: Material; main floor, 6 mil poly air/vapour barrier

CONVENTIONAL PRACTICE: 4 mil poly

CHANGES FROM CONVENTIONAL PRACTICE:

- Replace 4 mil poly with 6 mil on main walls and ceiling

| | | |
|---|---|---|
| GROSS COST: | $ 52.22 | m |
| | 60.00 | l |
| | $112.22 | |
| LESS SAVINGS: | $ 34.74 | m |
| | 60.00 | l |
| | $ 94.74 | |
| NET COST: | $ 17.48 | m |
| | 0 | l |
| | $ 17.48 | |

---

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Does not include any additional sealing, material change only.
2. Total wall and ceiling area 181 m² (1947 ft²).

SYSTEM COMPONENTS: Material; basement, 6 mil poly air/vapour barrier

CONVENTIONAL PRACTICE: 4 mil poly

CHANGES FROM CONVENTIONAL PRACTICE:

- o Replace 4 mil poly with 6 mil on basement walls, excluding header areas

| | | |
|---|---|---|
| GROSS COST: | $23.98 | m |
| | 18.00 | l |
| | $41.98 | |
| LESS SAVINGS: | $15.95 | m |
| | 18.00 | l |
| | $33.95 | |
| NET COST: | $ 8.03 | m |
| | 0 | l |
| | $ 8.03 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Does not include any additional sealing, material change only.
2. Total wall and ceiling area 87 $m^2$ (932 $ft^2$).

SYSTEM COMPONENT: Main floor walls; continuous, sealed poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly, stapled, no caulking

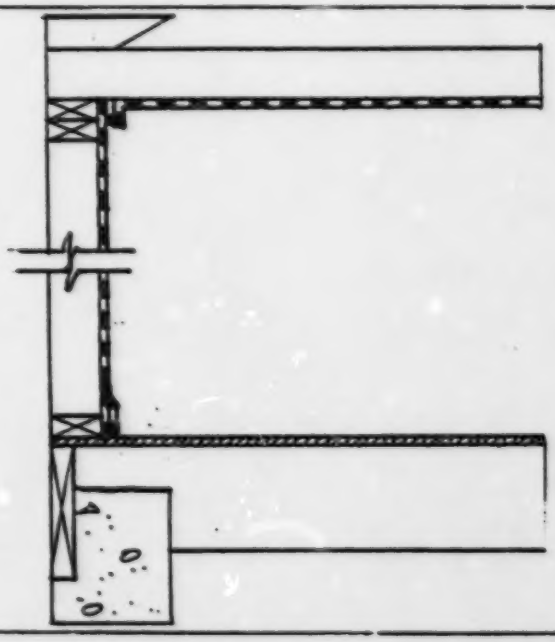
CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply acoustical sealant to seal:
  - top plate
  - bottom plate
  - lap joints in poly
- o Approx. 3.9 tubes of caulking required

| | | |
|---|---|---|
| GROSS COST: | $19.37 | m |
| | 10.00 | l |
| | $29.37 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $19.37 | m |
| | 10.00 | l |
| | $29.37 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:50 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Assumes poly installed prior to partition walls.
2. Does not include sealing of:
   - windows and doors
   - electrical outlets
   - ceiling
   - headers

SYSTEM COMPONENT: Basement walls; continuous, sealed poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly, stapled, no caulking

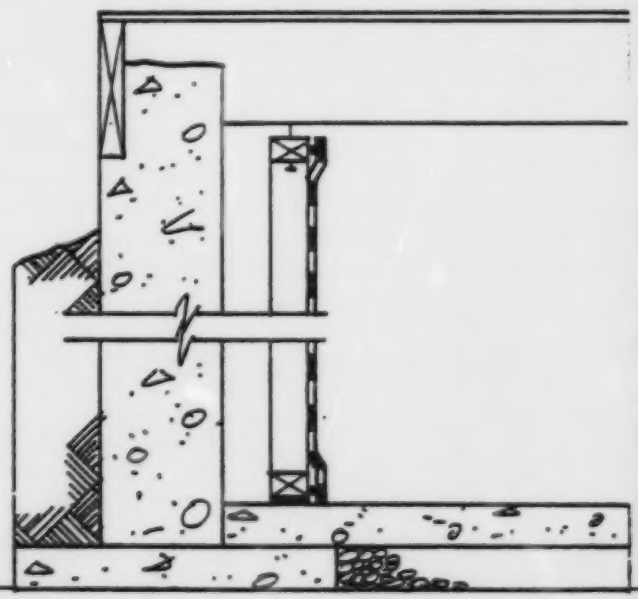
CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply acoustical sealant to seal:
  - top plate
  - bottom plate
  - lap joints in poly
- o Approx. 3.8 tubes of caulking required
- o Apply 89 mm (3½") sill plate gasket under bottom plate, approx. 40 m (130') required

| | | |
|---|---|---|
| GROSS COST: | $32.84 | m |
| | 14.00 | l |
| | $46.84 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $32.84 | m |
| | 14.00 | l |
| | $46.84 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 1:10 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Does not include sealing of:
   - basement windows
   - electrical outlets
   - headers

SYSTEM COMPONENT: Wall/header; exterior air barrier

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

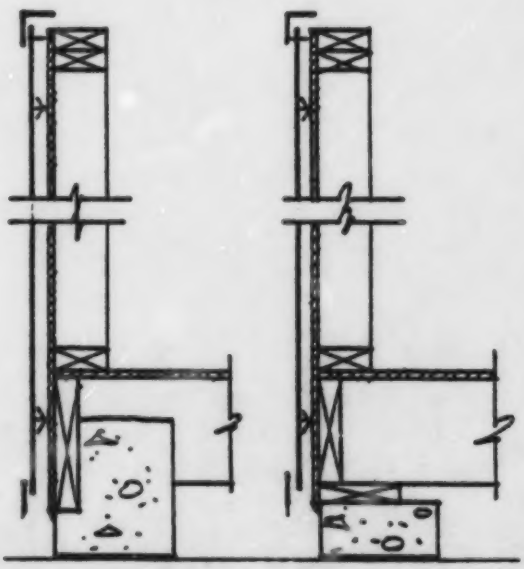
CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply polyolefin sheet to exterior of framed wall from top plate to bottom of header or sill plate to serve as air barrier
- o Tape all joints and penetrations with sheathing tape
- o Caulk joint between header and foundation or sill plate and foundation, approx. 4 tubes of caulking required
- o Polyolefin sheet replaces building paper

| | | |
|---|---|---|
| GROSS COST: | $134.83 | m |
| | 37.50 | l |
| | $172.33 | |
| LESS SAVINGS: | $ 19.22 | m |
| | 30.00 | l |
| | $ 49.22 | |
| NET COST: | $115.61 | m |
| | 7.50 | l |
| | $123.11 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Rigid exterior glass fibre insulated sheathing comes complete with polyolefin air barrier.

SYSTEM COMPONENT: Doors and windows; ethafoam rod

CONVENTIONAL PRACTICE: Glass fibre insulation stuffed into space between rough opening and jamb

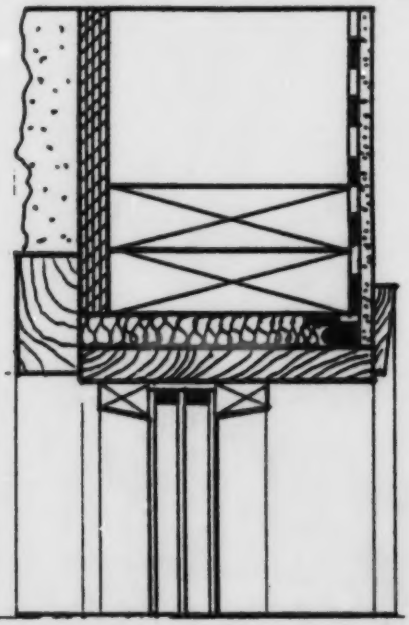
CHANGES FROM CONVENTIONAL PRACTICE:

- o After glass fibre batts have been stuffed around jambs, force fit appropriate diameter ethafoam rod into space to sit against drywall
- o Approx. 53 m (175') of joints to be gasketed

| | | |
|---|---|---|
| GROSS COST: | $ 8.36 | m |
| | 22.50 | l |
| | $ 30.86 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 8.36 | m |
| | 22.50 | l |
| | $ 30.86 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Requires several different sizes of ethafoam rods to be kept on site. Available in at least 8 sizes between 6 mm (¼") and 38 mm (1½").
2. Glass fibre jammed into space between window and door frames and rough openings to provide insulating value.

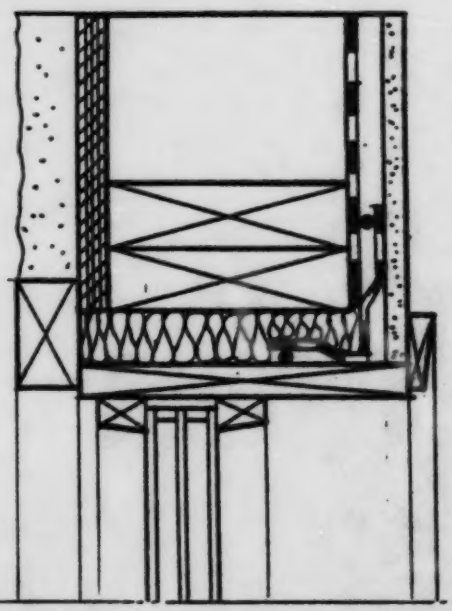
SYSTEM COMPONENT: Doors and windows; poly-wrap

CONVENTIONAL PRACTICE: Glass fibre insulation stuffed into space between rough opening and jamb

CHANGES FROM CONVENTIONAL PRACTICE:

- o Poly-wrap all doors and windows; caulk and staple poly to frames; seal window/door poly to main wall poly
- o Approx. ½ tube (average) of caulking required per window or door
- o Seal 7 windows and 2 doors

| | | |
|---|---|---|
| GROSS COST: | $ 16.60 | m |
| | 67.50 | l |
| | $ 84.10 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 16.60 | m |
| | 67.50 | l |
| | $ 84.10 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 4:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

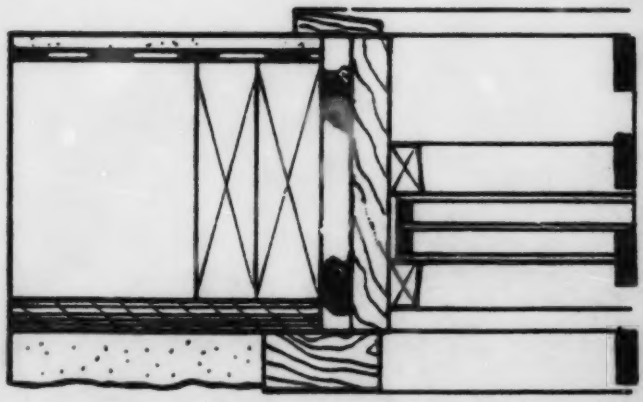
1. Glass fibre jammed into space between window and door frames and rough openings to provide insulating value.

SYSTEM COMPONENT: Doors and Windows; urethane

CONVENTIONAL PRACTICE: Glass fibre insulation stuffed into space between rough-opening and jamb

CHANGES FROM CONVENTIONAL PRACTICE:
- o Eliminate glass fibre insulation.
- o Apply two beads of single component polyurethane foam into rough opening spaces.

| | | |
|---|---|---|
| GROSS COST: | $10.34 | m |
| | 15.00 | l |
| | $25.34 | |
| LESS SAVINGS: | $ 0 | m |
| | 7.50 | l |
| | $ 7.50 | |
| NET COST: | $10.34 | m |
| | 7.50 | l |
| | $17.84 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:
1. Assumed foam usage is 150 m (500 l.f.) of 13 mm (½") bead per 1 kg can.

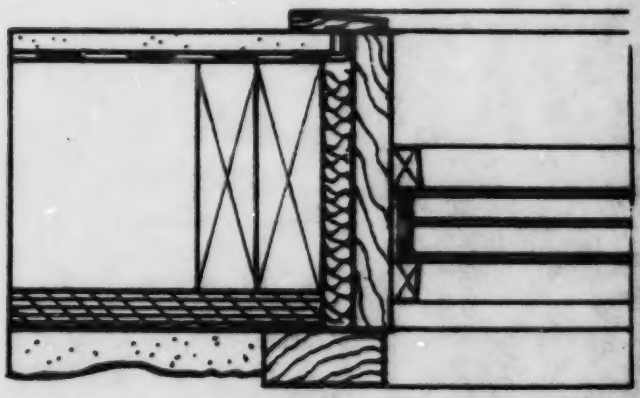
SYSTEM COMPONENT: Doors and Windows; poly-return

CONVENTIONAL PRACTICE: Glass fibre insulation stuffed into space between rough-opening and jamb

CHANGES FROM CONVENTIONAL PRACTICE:

- o Extend exterior wall polyethylene to overlap window and door frames, caulk and staple to frames and trim polyethylene as necessary.
- o Approximately ¼ tube (average) of caulking required per window or door.

| | | |
|---|---|---|
| GROSS COST: | $ 9.96 | m |
| | 33.75 | l |
| | $43.71 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 9.96 | m |
| | 33.75 | l |
| | $43.71 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 2:15 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Conventional glass fibre insulation is still used to provide insulating value.

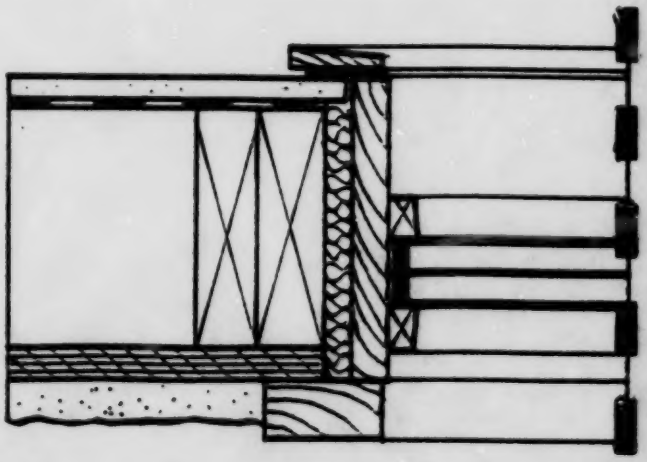
SYSTEM COMPONENT: Doors and Windows: casing tape

CONVENTIONAL PRACTICE: Glass fibre insulation stuffed into space between rough-opening and jamb

CHANGES FROM CONVENTIONAL PRACTICE:

- Apply contractors sheathing tape across gap between drywall and window frame. Trim as necessary and cover with casing.

| | | |
|---|---|---|
| GROSS COST: | $10.63 | m |
| | 11.25 | l |
| | $21.88 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $10.63 | m |
| | 11.25 | l |
| | $21.88 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FINISH CARPENTERS | 0:45 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Conventional glass fibre insulation is still used to provide insulating value.

SYSTEM COMPONENT: Wall/floor/foundation; poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

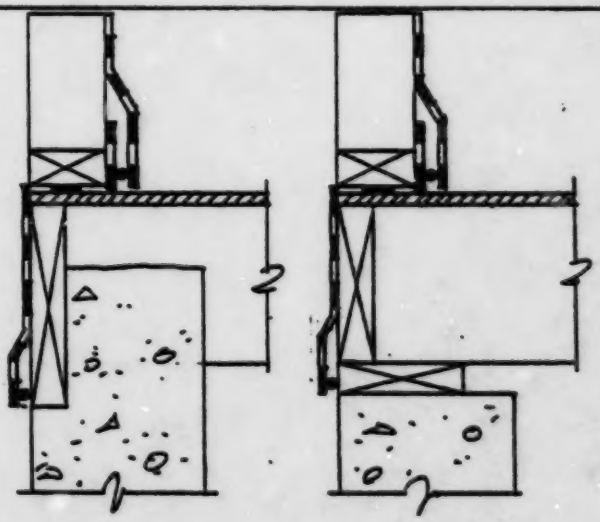
CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply poly strip around headers as shown, seal at points A and B with acoustical sealant
- o Apply strip of building paper on top of poly to provide protection when wall is raised
- o Approx. 4 tubes of caulking required

| | | |
|---|---|---|
| GROSS COST: | $ 26.48 | m |
| | 22.50 | l |
| | $ 48.98 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 26.48 | m |
| | 22.50 | l |
| | $ 48.98 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. This detail can only be used when exterior insulation is used which will prevent condensation in the header area (if no exterior insulation is used, see system A-9 or use a recessed header).
2. Caulking bead at point "B" should be wide enough to seal crack between the header/sill plate and the concrete and yet permit poly to be stapled to header/sill plate through the bead.

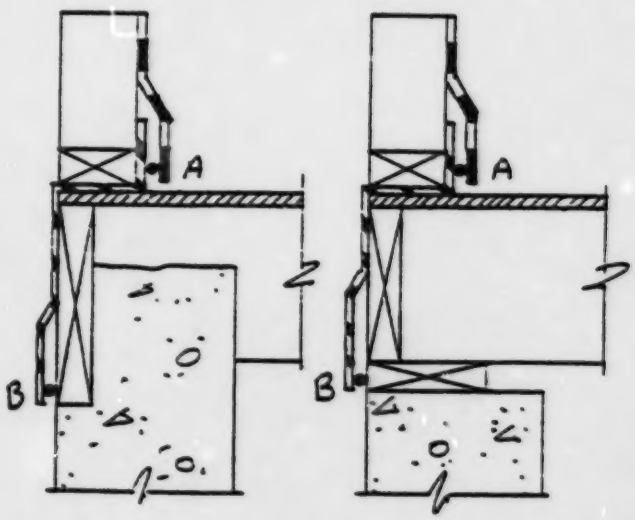
SYSTEM COMPONENT: Wall/floor/foundation; polyolefin air barrier

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply polyolefin strip around headers as shown. Seal at points A and B with acoustical sealant
- o Approx. 4 tubes of caulking required

| | | |
|---|---|---|
| GROSS COST: | $ 39.04 | m |
| | 20.00 | l |
| | $ 59.04 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 39.04 | m |
| | 20.00 | l |
| | $ 59.04 | |




ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:20 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Does not require exterior insulation to be applied over polyolefin sheet.
2. Caulking bead at point "B" should be wide enough to seal crack between the header/sill plate and the concrete and yet permit poly to be stapled to header/sill plate through the bead.

AIRTIGHTNESS A-13(a)

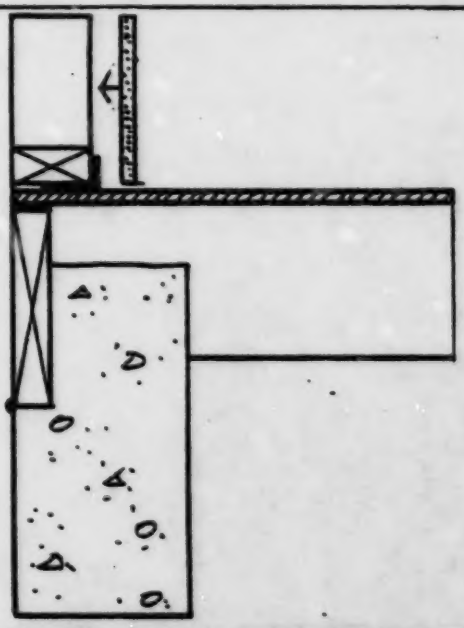
SYSTEM COMPONENT: Wall/floor/cast-in-place foundation; gasket sealing

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Apply 140 mm (5½") sill plate gasket under bottom plate, fold end up to seal face of plate against drywall
- o Apply 6mmx10mm (1/4"x3/8") open cell neoprene gasket to top of header
- o Caulk joint between header and foundation, approx. 2.2 tubes of caulking required

| | | |
|---|---|---|
| GROSS COST: | $ 53.37 | m |
| | 25.00 | l |
| | $ 78.37 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 53.37 | m |
| | 25.00 | l |
| | $ 78.37 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:40 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Single 140 mm (5½") sill plate gasket can be replaced by 2 soft, open cell gaskets.

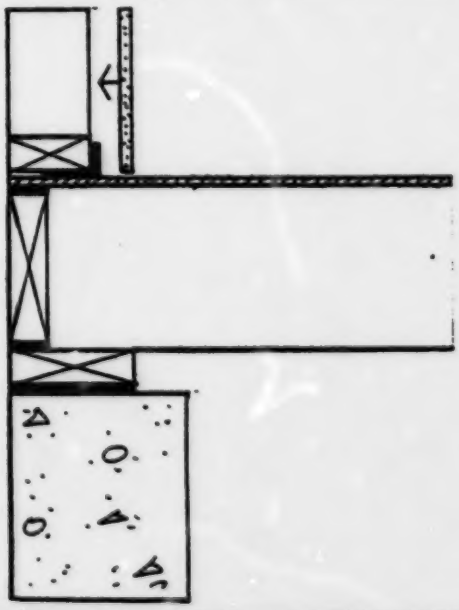
SYSTEM COMPONENT: Wall/floor/sill plate foundation; gasket sealing

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- Apply 140 mm (5½") sill plate gasket under bottom plate, fold end up to seal face of plate against drywall
- Apply 6mmx10mm (1/4"x3/8") open cell neoprene gasket to top and bottom of header
- Apply 140 mm (5½") sill plate gasket between sill plate and foundation

| | | |
|---|---|---|
| GROSS COST: | $ 84.82 | m |
| | 33.75 | l |
| | $118.57 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 84.82 | m |
| | 33.75 | l |
| | $118.57 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 2:15 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Single 140 mm (5½") sill plate gasket under bottom plate can be replaced by 2 soft, open cell gaskets.

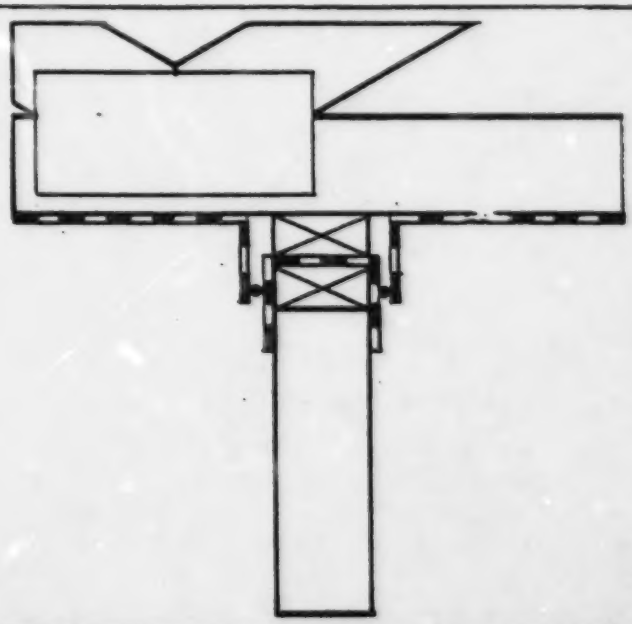
SYSTEM COMPONENT: Ceiling; poly air/vapour barrier sealed to partition walls

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install continuous sheets of poly, seal all joints
- o Install 300 mm (12") strips of poly along partition walls, seal to ceiling poly
- o Approx. 3.8 tubes of caulking required
- o Mate ceiling poly to main wall poly

| | | |
|---|---|---|
| GROSS COST: | $ 18.92 | m |
| | 22.50 | l |
| | $ 41.42 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 18.92 | m |
| | 22.50 | l |
| | $ 41.42 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:30 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Suitable for load-bearing partition walls where partition wall must be installed prior to trusses.
2. Assumes caulking of main wall/ceiling joint accounted for in main floor wall sealing.

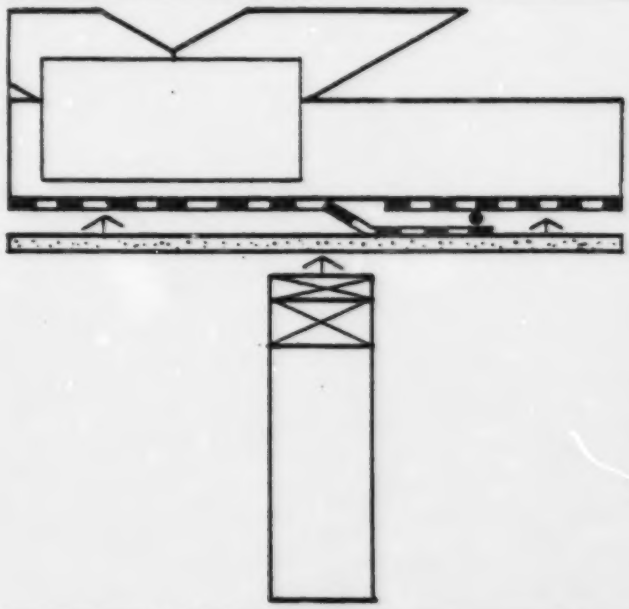
SYSTEM COMPONENT: Ceiling; continuous sealed poly air/vapour barrier

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install continuous sheets of poly, seal all joints, drywall and tape ceiling prior to framing partition walls
- o Approx. 1.1 tubes of caulking required
- o Mate ceiling poly to main wall poly
- o Use 19x89 (1x4) plate on top of partition walls instead of 38x89 (2x4) to provide clearance for drywall

| | | |
|---|---|---|
| GROSS COST: | $ 5.48 | m |
| | 3.00 | l |
| | $ 8.48 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 15.00 | l |
| | $ 20.29 | |
| NET COST: | $ 0.19 | m |
| | -12.00 | l |
| | $-11.81 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | -0:45 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Assumes caulking of main wall/ceiling joint accounted for in main floor wall sealing.
2. May require re-scheduling between framers and drywallers since ceiling drywall has to be installed and taped before partitions are framed.

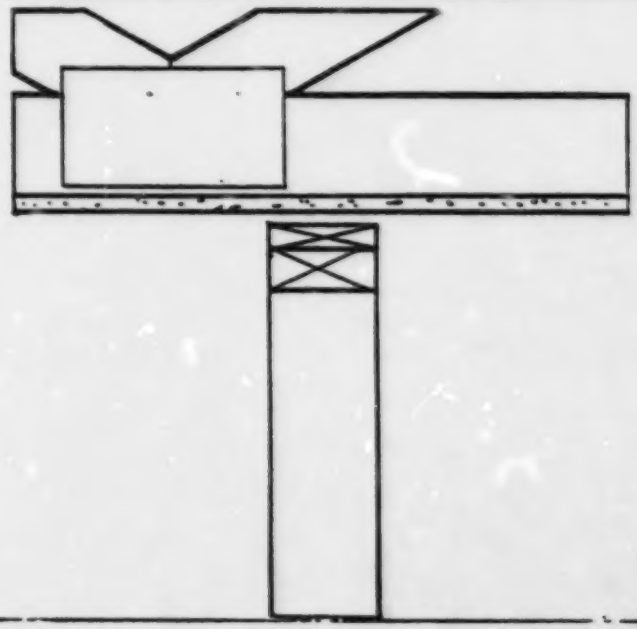
SYSTEM COMPONENT: Ceiling; continuous taped drywall air barrier (ADA)

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install and tape drywall prior to framing partition walls, no poly used
- o Use 19x89 (1x4) plate on top of partition walls instead of 38x89 (2x4) to provide clearance for drywall

| | | |
|---|---|---|
| GROSS COST: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 15.00 | l |
| | $ 20.29 | |
| NET COST: | $ -5.29 | m |
| | -15.00 | l |
| | $-20.29 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -1:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Requires ceiling paint to serve as vapour barrier see Sheet A-21.
2. May require re-scheduling between framers and drywallers since ceiling drywall has to be installed and taped before partitions are framed.

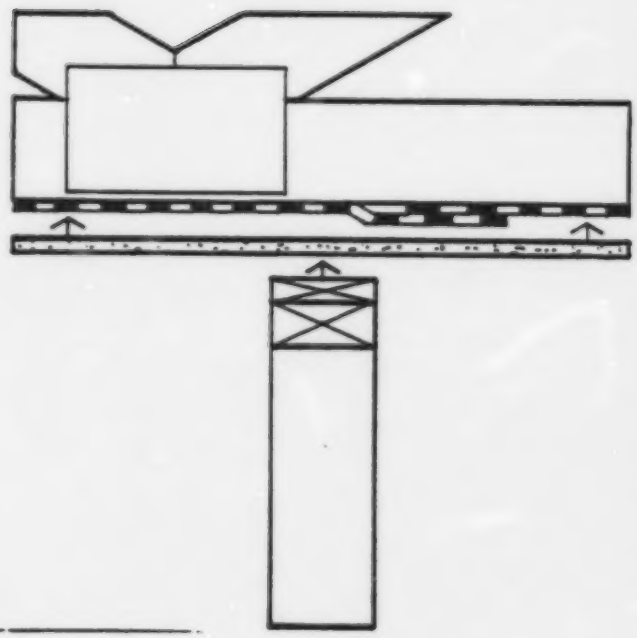
SYSTEM COMPONENT: Ceiling; continuous taped drywall air barrier (ADA), poly vapour barrier

CONVENTIONAL PRACTICE: Poly stapled, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

- o Install stapled, 4 mil poly prior to partition wall (conventional practice)
- o Use 19x89 (1x4) plate on top of partition walls instead of 38x89 (2x4) to provide clearance for drywall

| | | |
|---|---|---|
| GROSS COST: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 15.00 | l |
| | $ 20.29 | |
| NET COST: | $ -5.29 | m |
| | -15.00 | l |
| | $-20.29 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | -1:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Poly serves as vapour barrier.
2. May require re-scheduling between framers and drywallers since ceiling drywall has to be installed and taped before partitions are framed.

SYSTEM COMPONENT: Headers; interior rigid air/vapour barrier

CONVENTIONAL PRACTICE: Poly stapled in-header spaces, no caulking

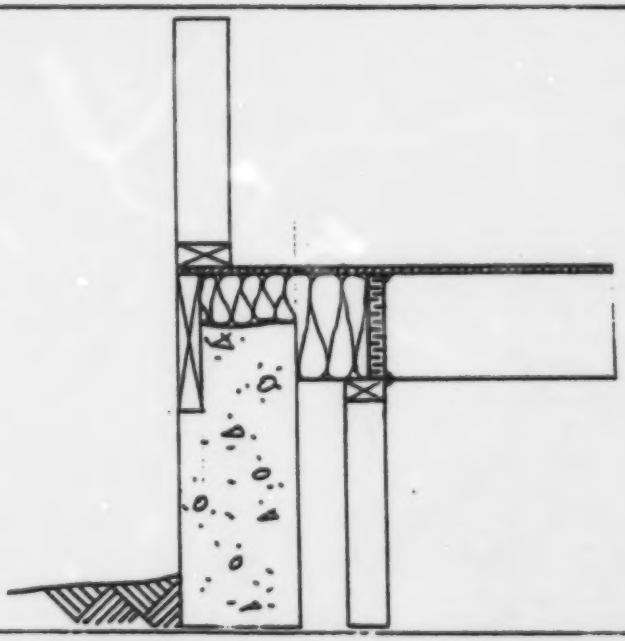
CHANGES FROM CONVENTIONAL PRACTICE:

- o Install 25 mm (1") extruded polystyrene in each header space. Caulk in place, approx. 4.8 tubes required

| | | |
|---|---|---|
| GROSS COST: | $ 61.16 | m |
| | 144.00 | l |
| | $205.16 | |
| LESS SAVINGS: | $ 1.55 | m |
| | 36.00 | l |
| | $ 37.55 | |
| NET COST: | $ 59.61 | m |
| | 108.00 | l |
| | $167.61 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 9:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Can be difficult to install where headers run parallel to joists.

SYSTEM COMPONENT: Headers; insulation-filled poly bags with RSI 2.11 (R-12.0)

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

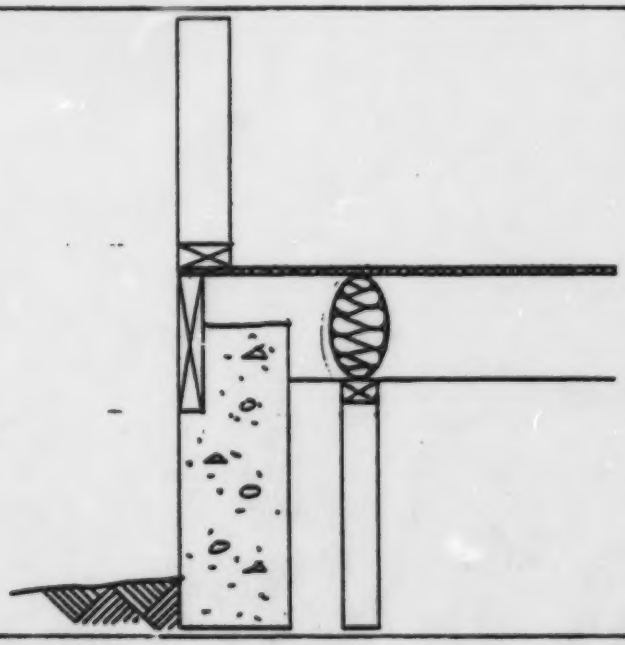
CHANGES FROM CONVENTIONAL PRACTICE:

o Install insulation-filled poly bags with RSI 2.11 (R-12.0) into header spaces

| | | |
|---|---|---|
| GROSS COST: | $ 28.59 | m |
| | 12.00 | l |
| | $ 40.59 | |
| LESS SAVINGS: | $ 23.25 | m |
| | 54.00 | l |
| | $ 77.25 | |
| NET COST: | $ 5.34 | m |
| | -42.00 | l |
| | $-36.66 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -3:30 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. "Less Savings" includes cost of the RSI 2.11 (R-12.0) insulation used in conventional practice.
2. May require separate air barrier or that the house be operated under a negative pressure differential.
3. Poly bags function as vapour barrier.

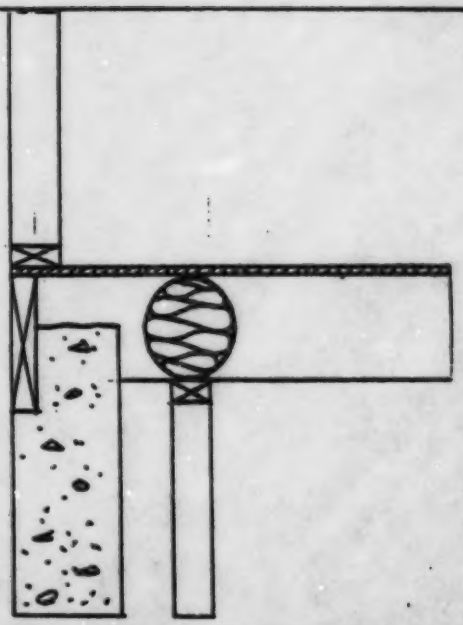
SYSTEM COMPONENT: Headers; insulation-filled poly bags with RSI 3.52 (R-20.0)

CONVENTIONAL PRACTICE: Poly stapled into header spaces, no caulking

CHANGES FROM CONVENTIONAL PRACTICE:

o Install insulation-filled poly bags with RSI 3.52 (R-20.0) into header spaces

| | | |
|---|---|---|
| GROSS COST: | $ 61.75 | m |
| | 12.00 | l |
| | $ 73.75 | |
| LESS SAVINGS: | $ 37.81 | m |
| | 54.00 | l |
| | $ 91.81 | |
| NET COST: | $ 23.94 | m |
| | -42.00 | l |
| | $-18.06 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -3:30 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. "Less Savings" includes cost of the RSI 3.52 (R-20.0) insulation used in conventional practice.
2. May require separate air barrier or that the house be operated under a negative pressure differential.
3. Poly bags function as vapour barrier.

SYSTEM COMPONENT: Electrical outlets, main floor; rigid poly pans

CONVENTIONAL PRACTICE: Loose poly wrap

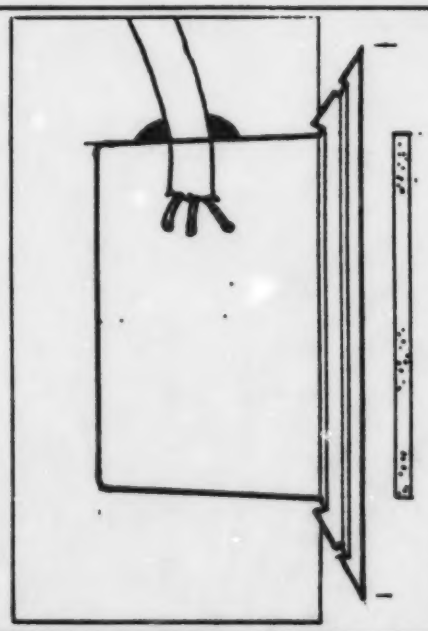
CHANGES FROM CONVENTIONAL PRACTICE:

- o Use manufactured rigid poly pans with face plate gaskets for electrical outlets on exterior walls, caulk poly pans to air barrier

| | | |
|---|---|---|
| GROSS COST: | $ 6.25 | m |
| | 10.21 | l |
| | $ 16.46 | |
| LESS SAVINGS: | $ 0 | m |
| | 5.10 | l |
| | $ 5.10 | |
| NET COST: | $ 6.25 | m |
| | 5.11 | l |
| | $ 11.36 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:17 M/H |



NOTES:

1. Assumes 7 duplex plugs or switches on exterior walls.
2. Some plugs and switches were initially relocated from exterior to interior walls.
3. Requires drywallers to caulk poly pans to drywall.

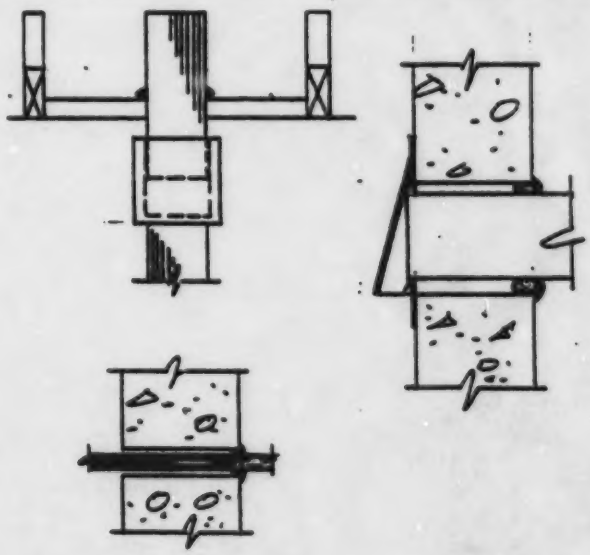
SYSTEM COMPONENT: Service penetrations

CONVENTIONAL PRACTICE: Unsealed

CHANGES FROM CONVENTIONAL PRACTICE:

- o Caulk and seal penetrations for:
  - plumbing stack
  - main electrical service
  - dryer vent
  - hose bib
  - exterior electrical outlet
  - outdoor light
- o For larger joints, apply ethafoam rod into joint to serve as a backer rod, then caulk
- o For smaller joints, apply caulking directly into joint

| | | |
|---|---|---|
| GROSS COST: | $ 5.00 | m |
| | 11.25 | l |
| | $ 16.25 | |
| LESS SAVINGS: | $ 0 | m |
| | 0 | l |
| | $ 0 | |
| NET COST: | $ 5.00 | m |
| | 11.25 | l |
| | $ 16.25 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:45 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Sealing of HRV inlet and outlet duct penetrations not included.
2. Approx. 0.75 tubes of caulking and 2 m (6') of ethafoam rod required.

SYSTEM COMPONENT: Exterior attic hatch

CONVENTIONAL PRACTICE: See note below

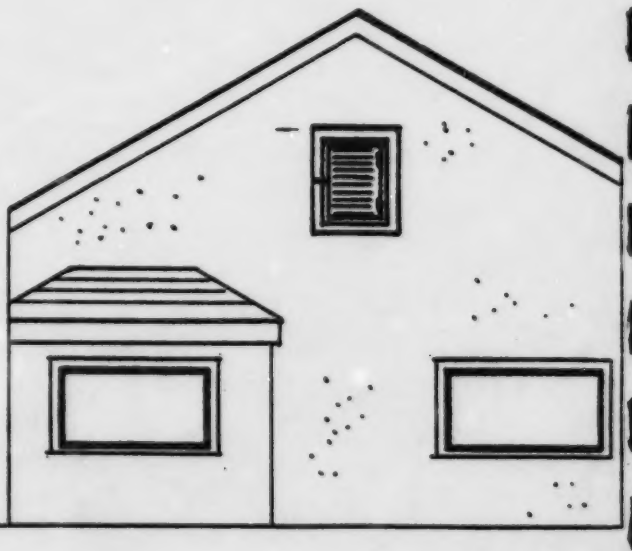
CHANGES FROM CONVENTIONAL PRACTICE:

- o Replace interior attic hatch with exterior, gable hatch

| | | |
|---|---|---|
| GROSS COST: | $ | 0 m<br>0 l<br>0 |
| LESS SAVINGS: | $ | 0 m<br>0 l<br>0 |
| NET COST: | $ | 0 m<br>0 l<br>0 |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Exterior attic hatches are becoming typical for conventional construction, however comparison is made to an interior hatch to note incremental cost.

SYSTEM COMPONENT: Sealed floor drain cover

CONVENTIONAL PRACTICE: Open floor drain cover

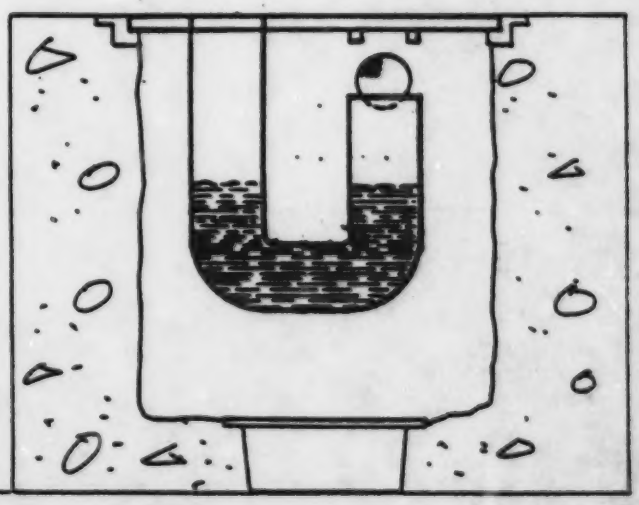
CHANGES FROM CONVENTIONAL PRACTICE:

- Use self-sealing floor drain cover c/w retaining ring in place of conventional drain

| | | |
|---|---|---|
| GROSS COST: | $ 29.95 | m |
| | 0 | l |
| | $ 29.95 | |
| LESS SAVINGS: | $ 10.00 | m |
| | 0 | l |
| | $ 10.00 | |
| NET COST: | $ 19.95 | m |
| | 0 | l |
| | $ 19.95 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:00 M/H |



NOTES:

1. Model also available for sumps.
2. System also reduces radon migration.

SYSTEM COMPONENT: Painted vapour barrier, main walls and ceiling

CONVENTIONAL PRACTICE: 4 mil poly stapled, no caulking with the following point schedule:

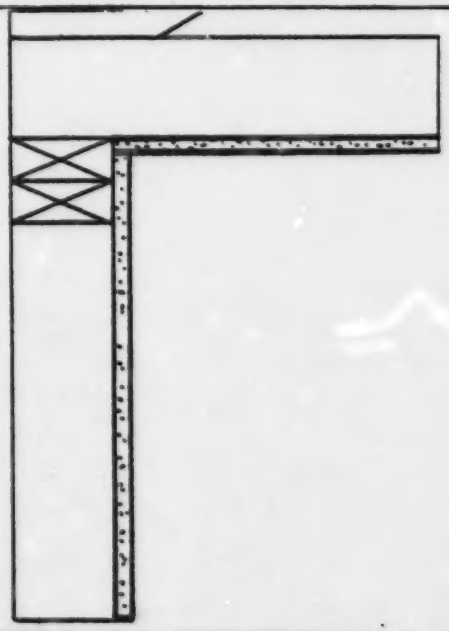
Walls - 1 coat latex sealer/primer
1 coat flat latex interior

Ceiling - 1 coat latex sealer/primer
texture finish coat

CHANGES FROM CONVENTIONAL PRACTICE:

- o Revise point schedule as follows:
  - Main walls - latex primer
    - oil base primer
    - latex finish coat
  - Ceilings - latex primer
    - oil base primer
    - texture finish coat
- o Omit poly vapour barrier

| | | |
|---|---|---|
| GROSS COST: | $ 70.00 | m |
| | 82.50 | l |
| | $152.50 | |
| LESS SAVINGS: | $ 32.05 | m |
| | 60.00 | l |
| | $ 92.05 | |
| NET COST: | $ 37.95 | m |
| | 22.50 | l |
| | $ 60.45 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -5:00 M/H |
| PAINTERS | 5:30 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. "Gross Cost" covers application of oil base primers coat.
2. Painted drywall surface serves as the vapour barrier.
3. Latex primer is used to prevent the oil-based primer from raising the paper nap on drywall.
4. Assumes 89 m² (956 ft²) of wall area and 92 m² (991 ft²) of ceiling area painted.
5. Partition walls painted as per conventional schedule.

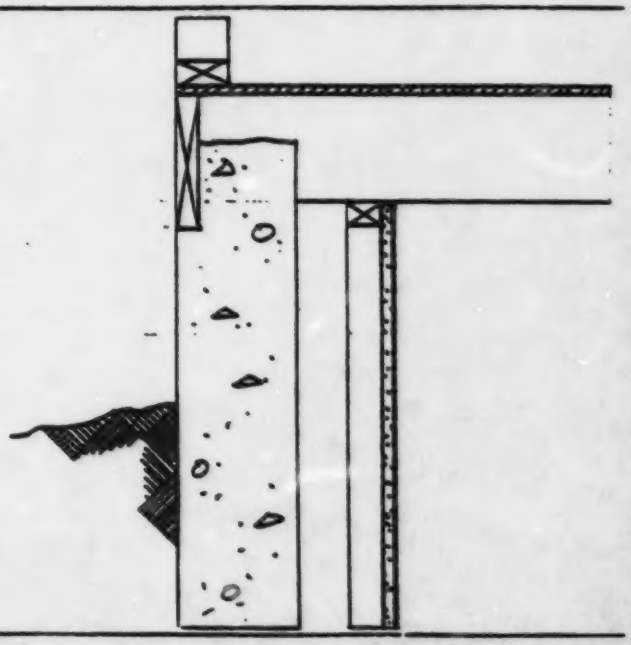
SYSTEM COMPONENT: Painted vapour barrier, basement walls

CONVENTIONAL PRACTICE: 4 mil poly stapled, no caulking with the following point schedule:
1 coat latex sealer/primer
1 coat flat latex interior

CHANGES FROM CONVENTIONAL PRACTICE:

- Revise point schedule as follows:
  Basement walls - latex primer
  - oil base primer
  - latex finish coat
- Omit poly vapour barrier

| | | |
|---|---|---|
| GROSS COST: | $ 35.00 | m |
| | 22.50 | l |
| | $ 57.50 | |
| LESS SAVINGS: | $ 15.34 | m |
| | 18.00 | l |
| | $ 33.34 | |
| NET COST: | $ 19.66 | m |
| | 4.50 | l |
| | $ 24.16 | |



ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 0:00 M/H |
| DRYWALLERS/INSULATORS | -1:30 M/H |
| PAINTERS | 1:30 M/H |
| ELECTRICIANS | 0:00 M/H |

NOTES:

1. Painted drywall surface serves as the vapour barrier.
2. Latex primer is used to prevent the oil-based primer from raising the paper nap on drywall.
3. Assumes 87 m² (932 ft²) of wall area.
4. Partition walls painted as per conventional schedule.

SYSTEM: Sealed poly air/vapour barrier envelope

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Material; main floor, 6 mil poly (A-1)
- o Material; basement 6 mil poly (A-2)
- o Main floor walls, continuous sealed poly (A-3)
- o Windows and door; poly-wrap (A-7)
- o Wall/floor/foundation; polyolefin (A-12)
- o Ceiling; continuous sealed poly (A-15)
- o Electrical outlets; main floor (A-20)
- o Service penetrations (A-21)
- o Exterior attic hatch (A-22)

| | | |
|---|---|---|
| GROSS COST: | $167.94 | m |
| | 199.96 | l |
| | $367.90 | |
| LESS SAVINGS: | $ 55.98 | m |
| | 98.10 | l |
| | $154.08 | |
| NET COST: | $111.96 | m |
| | 101.86 | l |
| | $213.82 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 6:40 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:17 M/H |

NOTES:

1. This is a well sealed "poly approach" house suitable for conventional framed walls walls with exterior insulated sheathing or walls with interior strapping.
2. System shown is for a conventionally-sealed unfinished basement, for low leakage sealing, add System A-4.

SYSTEM: Airtight Drywall Approach (painted vapour barrier)

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Windows and doors; ethafoam rod (A-6)
- o Wall/floor/foundation; gaskets (A-13(a))
- o Ceiling; continuous taped drywall (A-16)
- o Electrical outlets; main floor (A-20)
- o Service penetrations (A-21)
- o Exterior attic hatch (A-22)
- o Painted vapour barrier; main walls, ceiling (A-24)

| | | |
|---|---|---|
| GROSS COST: | $142.98 | m |
| | 151.46 | l |
| | $294.44 | |
| LESS SAVINGS: | $ 37.34 | m |
| | 80.10 | l |
| | $117.44 | |
| NET COST: | $105.64 | m |
| | 71.36 | l |
| | $177.00 | |

ADDITIONAL TIME REQUIRED:

| | | |
|---|---|---|
| FRAMERS | 2:55 | M/H |
| DRYWALLERS/INSULATORS | -5:00 | M/H |
| PAINTERS | 5:30 | M/H |
| ELECTRICIANS | 0:17 | M/H |

NOTES:

1. System shown is for an unfinished basement; for a finished basement, add System A-22.

AIRTIGHTNESS A-28

SYSTEM: Airtight Drywall Approach (poly vapour barrier)

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Windows and doors; ethafoam rod (A-6)
- o Wall/floor/foundation; gaskets (A-13(a))
- o Ceiling; continuous taped drywall (A-17)
- o Electrical outlets; main floor (A-20)
- o Service penetrations (A-21)
- o Exterior attic hatch (A-22)
- o Install 4 mil stapled poly; main walls (as per conventional practice)

| | | |
|---|---|---|
| GROSS COST: | $ 72.98 | m |
| | 68.96 | l |
| | $141.94 | |
| LESS SAVINGS: | $ 5.29 | m |
| | 20.10 | l |
| | $ 25.39 | |
| NET COST: | $ 67.69 | m |
| | 48.86 | l |
| | $116.55 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 2:55 M/H |
| DRYWALLERS/INSULATORS | 0:00 M/H |
| PAINTERS | 0:00 M/H |
| ELECTRICIANS | 0:17 M/H |

NOTES:

1. System shown is for a finished or unfinished basement.

SYSTEM: Fiberglas Canada Inc. Low Energy House System

CONVENTIONAL PRACTICE: See individual data sheets

CHANGES FROM CONVENTIONAL PRACTICE:

- o Windows and doors; ethafoam rod (A-6)
- o Ceiling; continuous taped drywall (A-16)
- o Headers; polyethylene bags (A-19(a))
- o Electrical outlets; main floor (A-20)
- o Service penetrations (A-21)
- o Exterior attic hatch (A-22)
- o Sealed floor drain cover (A-23)
- o Painted vapour barrier; main walls, ceiling (A-24)

| | | |
|---|---|---|
| GROSS COST: | $148.15 | m |
| | 138.46 | l |
| | $286.61 | |
| LESS SAVINGS: | $ 70.59 | m |
| | 134.10 | l |
| | $204.69 | |
| NET COST: | $ 77.56 | m |
| | 4.36 | l |
| | $ 81.92 | |

ADDITIONAL TIME REQUIRED:

| | |
|---|---|
| FRAMERS | 1:15 M/H |
| DRYWALLERS/INSULATORS | -8:30 M/H |
| PAINTERS | 5:30 M/H |
| ELECTRICIANS | 0:17 M/H |

NOTES:

1. Intended to be operated with the house under a slight negative pressure differential as supplied by the Habitair System (I-1).
2. Assumes exterior rigid glass fibre insulation on main and basement walls.

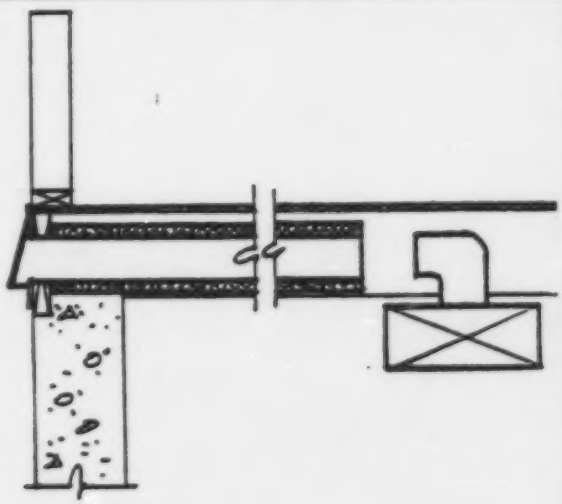
SYSTEM COMPONENT: Fresh air intake

SYSTEM COMPONENT DESCRIPTION:

- Intall 127mm (5") fresh air intake to return air plenum of furnace c/w insulation, vapour barrier, hood and screen and balancing damper. Assume 2.4m (8') duct run.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $45.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $45.00 |



NOTES:

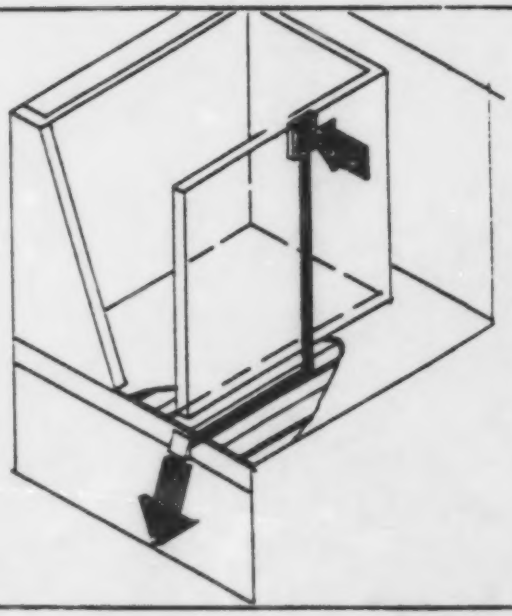
SYSTEM COMPONENT: Kitchen exhaust fan

SYSTEM COMPONENT DESCRIPTION:

- o Install exhaust fan in kitchen, duct down partition wall into basement and out header c/w exhaust hood, backdraft damper and wall-mounted switch. Assume 4.9m (16') of duct run.
- o Exhaust fan capacity (free stream) 61 l/s (130 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $100.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $126.00 |



NOTES:

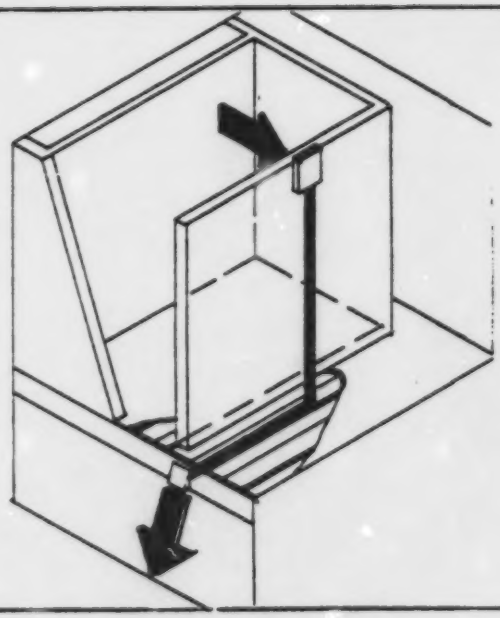
SYSTEM COMPONENT: Bathroom exhaust fan

SYSTEM COMPONENT DESCRIPTION:

- o Install exhaust fan in bathroom, duct down partition wall into basement and out header c/w exhaust hood, backdraft damper and wall-mounted switch. Assume 4.9m (16') of duct run.
- o Exhaust fan capacity (free stream) 24 l/s (50 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $60.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $86.00 |



NOTES:

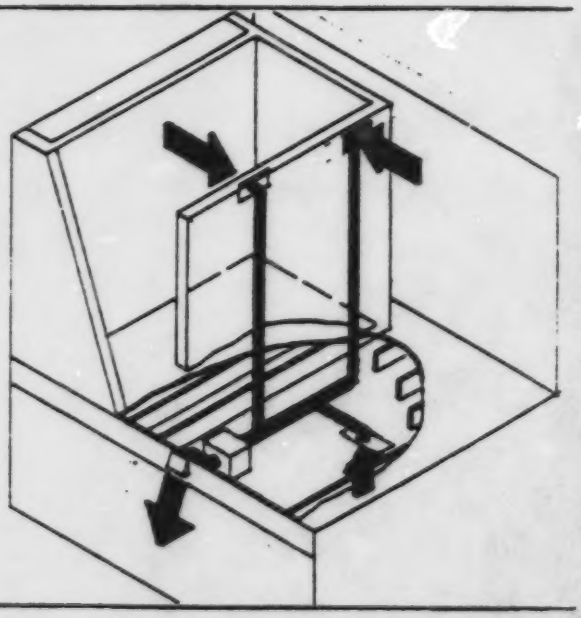
SYSTEM COMPONENT: Central exhaust

SYSTEM COMPONENT DESCRIPTION:

- o Install central exhaust in basement, drawing from bathroom and kitchen and exhausting out through header c/w 2 grilles, exhaust hood, backdraft damper and 2 switches (bathroom and kitchen).
- o Exhaust fan capacity free stream 113 l/s (240 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $400.00 |
| ELECTRICAL | 39.00 |
| PLUMBING | 0 |
| | $439.00 |



NOTES:

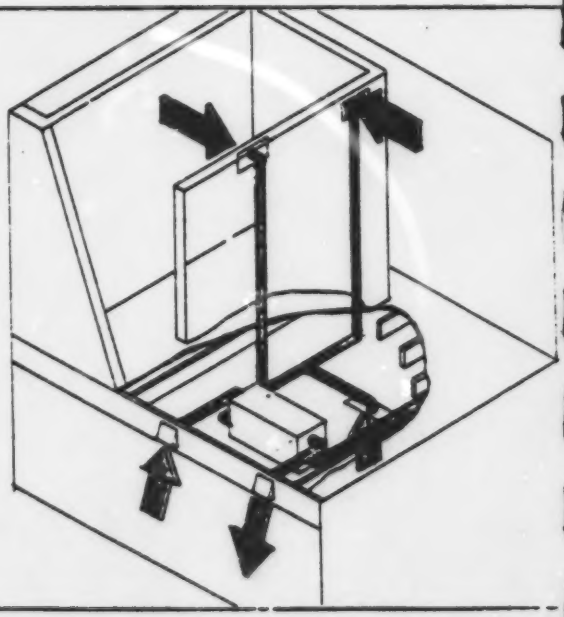
SYSTEM COMPONENT: Heat recovery ventilator, small capacity

SYSTEM COMPONENT DESCRIPTION:

- o Install small capacity HRV c/w insulated ductwork and vapour barrier between unit and outdoors, intake and exhaust hood, dehumidistat in hallway and switches in bathroom and kitchen. Capacity 47 l/s (100 CFM) @ 87 Pa and 50 Pa (0.35" and 0.20" $H_2O$) exhaust and supply static pressures.
- o HRV to exhaust from bathroom and kitchen (ductwork included).
- o HRV to supply air to return air plenum of heating system or dedicated ventilation-only duct system.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,300.00 |
| ELECTRICAL | 112.00 |
| PLUMBING | 30.00 |
| | $1,442.00 |



NOTES:

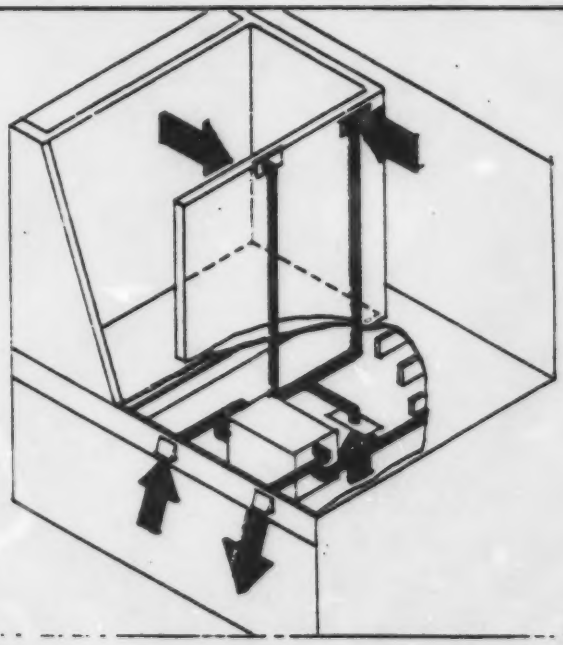
SYSTEM COMPONENT: Heat recovery ventilator, medium capacity

SYSTEM COMPONENT DESCRIPTION:

- o Install medium capacity HRV c/w insulated ductwork and vapour barrier between unit and outdoors, intake and exhaust hood, dehumidistat in hallway and switches in bathroom and kitchen. Capacity 102 l/s (216 CFM) @ 75 Pa (0.30" $H_2O$) static pressure.
- o HRV to exhaust from bathroom and kitchen (ductwork included).
- o HRV to supply air to return air plenum of heating system or dedicated ventilation-only duct system.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,600.00 |
| ELECTRICAL | 112.00 |
| PLUMBING | 30.00 |
| | $1,742.00 |



NOTES:

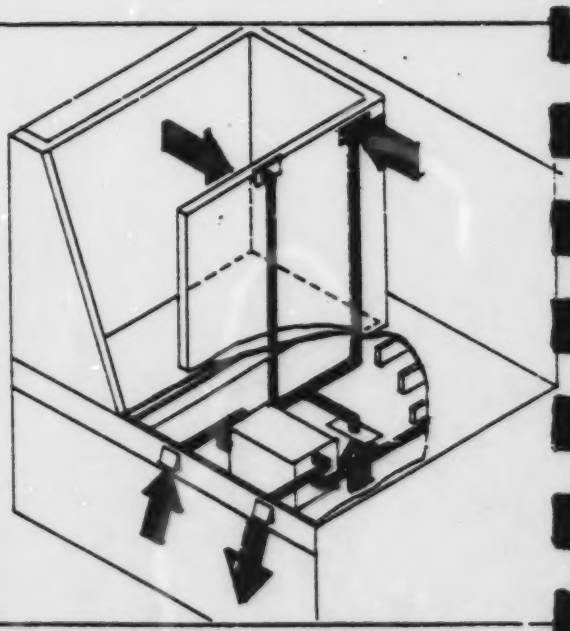
SYSTEM COMPONENT: Heat pump heat recovery ventilator

SYSTEM COMPONENT DESCRIPTION:

- o Install a heat pump HRV c/w insulated ductwork and vapour barrier between unit and outdoors, intake and exhaust hood, dehumidistat in hallway and switches in bathroom and kitchen. Capacity 125 l/s (265 CFM).
- o HRV to exhaust from bathroom and kitchen (ductwork included).
- o HRV to supply air to return air plenum of heating system or dedicated ventilation-only duct system.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $2,400.00 |
| ELECTRICAL | 268.00 |
| PLUMBING | 30.00 |
| | $2,698.00 |



NOTES:

1. This unit is similar in configuration and layout to more conventional HRV's but uses an air-to-air heat pump rather than a heat exchanger core to transfer heat between the exhaust and supply air streams.

SYSTEM COMPONENT: Dedicated ventilation-only supply system

SYSTEM COMPONENT DESCRIPTION:

- o Install duct system with 152 mm (6") main and 102 mm (4") branch ducts c/w 5 registers on main floor and 2 in basement.
- o Tape all ductwork.
- o Main floor registers to be mounted on partition walls within 0.3 m (1') of ceiling. Basement registers to be ceiling-mounted.
- o Duct system to start at HRV or supply air fan.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $475.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $475.00 |

see Figure V-8

NOTES:

1. Costs do not include HRV supply fan, or exhaust ductwork.
2. If 38x64 (2"x3") partition walls are used, branch ducts, 102 mm (4") will have to be compressed or equivalent rectangular ducting used.

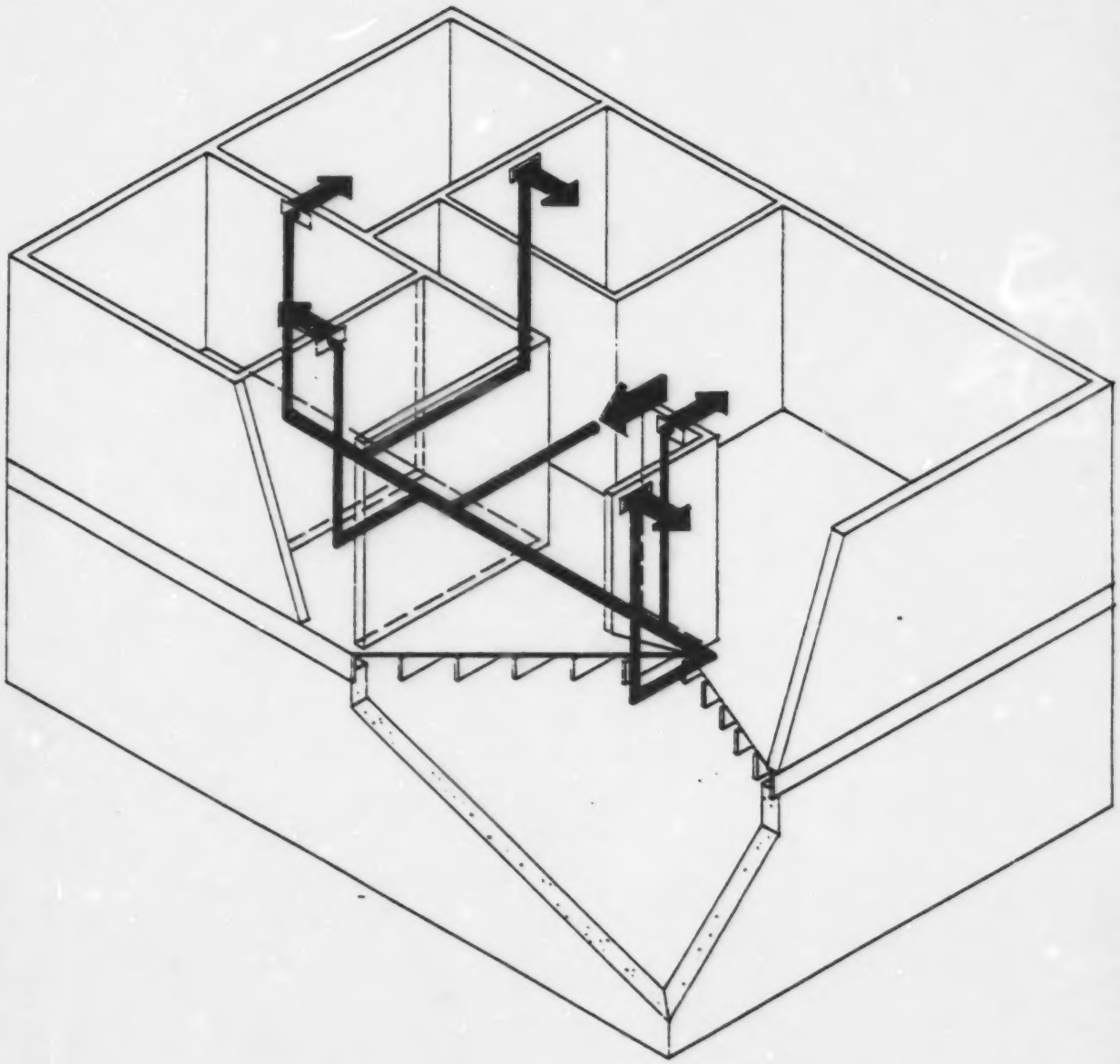


FIGURE V-8

SYSTEM COMPONENT: Dehumidistat

SYSTEM COMPONENT DESCRIPTION:

o Install 110 VAC dehumidistat in living room to provide automatic control of exhaust-only ventilation systems.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $55.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $81.00 |

NOTES:

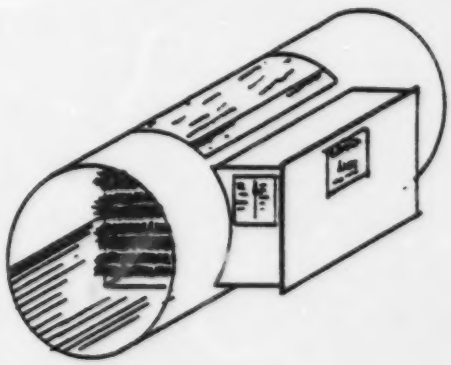
SYSTEM COMPONENT: Duct heater

SYSTEM COMPONENT DESCRIPTION:

o Install 2 kW heater in fresh air duct to preheat in-coming air.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $280.00 |
| ELECTRICAL | 90.00 |
| PLUMBING | 0 |
| | $370.00 |



NOTES:

1. Typically not required when an HRV or high side-wall supplies are used. Also, not recommended for a fresh air duct unless a supply air fan is used to provide adequate flow through heater.

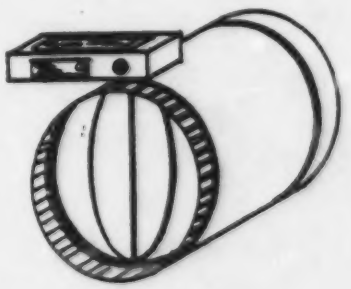
SYSTEM COMPONENT: Air control dampers

SYSTEM COMPONENT DESCRIPTION:

- Install automatic 152 mm (6") air control damper c/w wall-mounted switch, in exhaust duct from laundry room.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 95.00 |
| ELECTRICAL | 26.00 |
| PLUMBING | 0 |
| | $121.00 |



NOTES:

1. For control of air flows within zoned systems or for seldom-ventilated rooms.

SYSTEM: Conventional ventilation system

SYSTEM DESCRIPTION:

- o Fresh air intake (V-1)
- o Kitchen exhaust fan (V-2)
- o Bathroom exhaust fan (V-3)

| | |
|---|---|
| GROSS COST: | $257.00 |
| LESS SAVINGS: | 0 |
| NET COST: | $257.00 |

NOTES:

SYSTEM: Central exhaust system

SYSTEM DESCRIPTION:

- o Fresh air intake (V-1)
- o Central exhaust (V-4)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $565.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $308.00 |

NOTES:

SYSTEM: HRV system, small capacity for forced air heating system

SYSTEM DESCRIPTION:

- o HRV, small capacity (V-5)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $1,523.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $1,266.00 |

NOTES:

SYSTEM: HRV system, small capacity, for baseboard heating system

SYSTEM DESCRIPTION:

- o HRV, small capacity (V-5)
- o Dedicated ventilation-only duct system (V-8)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $1,998.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $1,741.00 |

NOTES:

SYSTEM: HRV system, medium capacity, for forced air heating system

SYSTEM DESCRIPTION:

- o HRV, medium capacity (V-6)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $1,823.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $1,566.00 |

NOTES:

SYSTEM: HRV system, medium capacity, for baseboard heating system

SYSTEM DESCRIPTION:

- o HRV, medium capacity (V-6)
- o Dedicated ventilation-only supply system (V-8)
- o Dehumidistat (V-9)

| | |
|---|---|
| GROSS COST: | $2,298.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $2,041.00 |

NOTES:

SYSTEM: Heat pump HRV system for forced air heating system

SYSTEM DESCRIPTION:

- o Heat pump HRV (V-7)

| | |
|---|---|
| GROSS COST: | $2,698.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $2,441.00 |

NOTES:

SYSTEM: Heat pump HRV system for baseboard heating system

SYSTEM DESCRIPTION:

- o Heat pump HRV (V-7)
- o Dedicated ventilation-only supply system (V-8)

| | |
|---|---|
| GROSS COST: | $3,173.00 |
| LESS SAVINGS: | 257.00 |
| NET COST: | $2,916.00 |

NOTES:

SPACE HEATING H-1

SYSTEM: Conventional gas furnace, 60% efficient

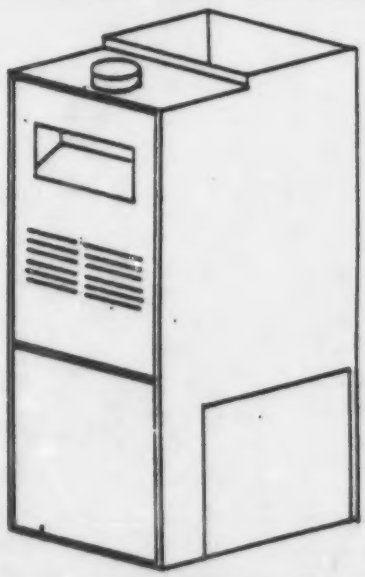
SYSTEM DESCRIPTION:

- o Install 18 kW input (60,000 Btu/Hr), naturally aspirated gas furnace c/w vent and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,425.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 0 |
| | $1,458.00 |

| | |
|---|---|
| GROSS COST: | $1,458.00 |
| LESS SAVINGS: | 0 |
| NET COST: | $1,458.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

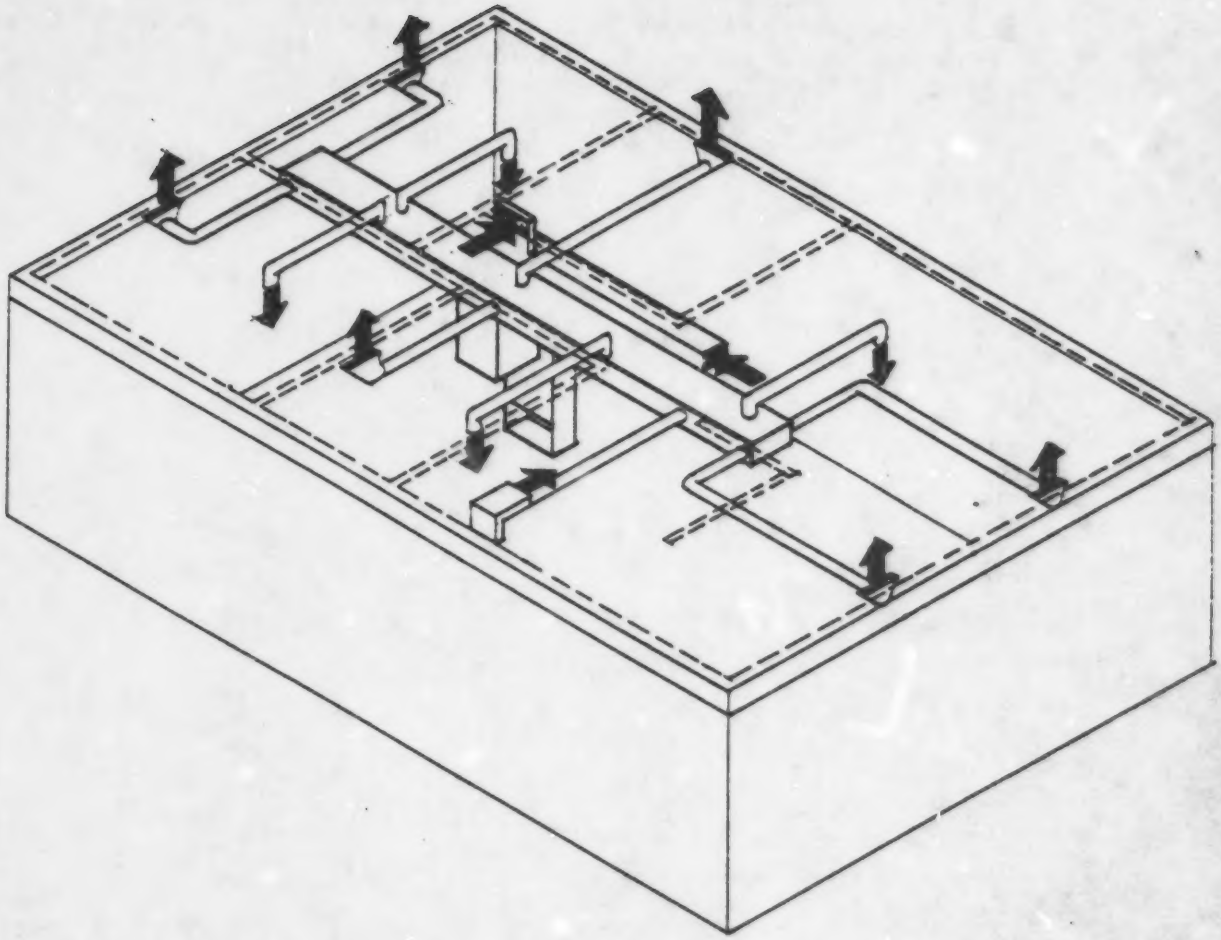


FIGURE H-1

SYSTEM: Naturally-aspirated gas furnace with spark ignition and vent damper, 69% efficient

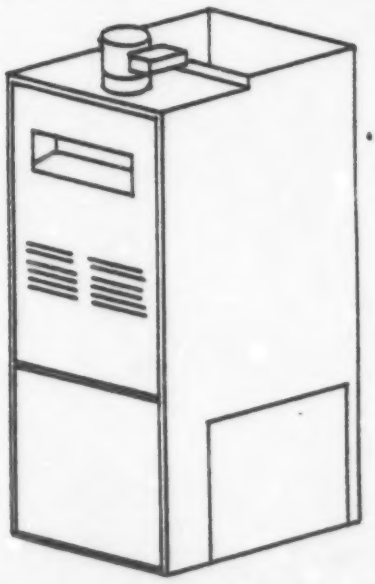
SYSTEM DESCRIPTION:

- o Install gas furnace c/w spark ignition, flue draft damper, continuous circulation blower and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,800.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 0 |
| | $1,833.00 |

| | |
|---|---|
| GROSS COST: | $1,833.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $ 375.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

SYSTEM: Induced draft gas furnace, 80% efficient

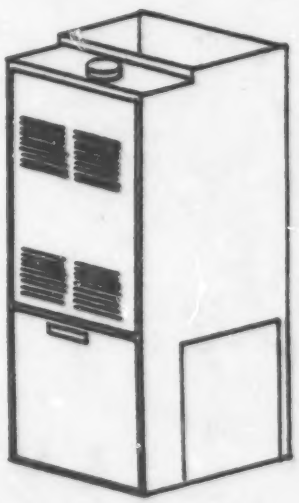
SYSTEM DESCRIPTION:

- o Install induced draft gas furnace and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,995.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 0 |
| | $2,028.00 |

| | |
|---|---|
| GROSS COST: | $2,028.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $ 570.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

SYSTEM: Condensing gas furnace, 95% efficient

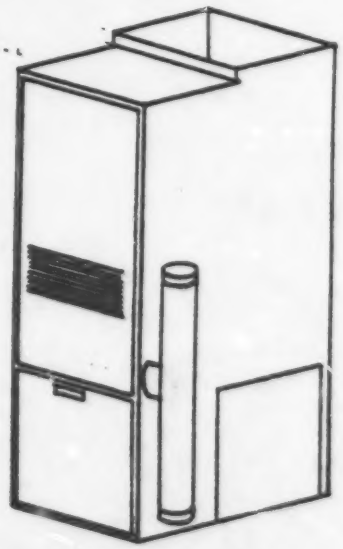
SYSTEM DESCRIPTION:

- o Install condensing gas furnace c/w continuous circulation blower and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $2,995.00 |
| ELECTRICAL | 33.00 |
| PLUMBING | 30.00 |
| | $3,058.00 |

| | |
|---|---|
| GROSS COST: | $3,058.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $1,600.00 |



NOTES:

1. Ductwork illustrated in Figure H-1.

SYSTEM: 10 kW electric furnace

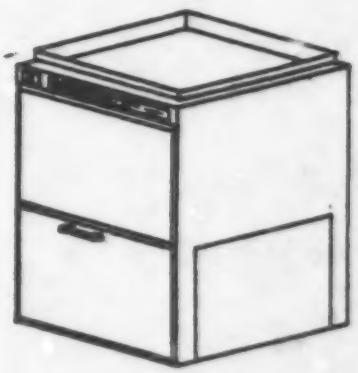
SYSTEM DESCRIPTION:

- o Install 10 kW electric furnace c/w continuous circulation blower and ductwork.
- o Install ductwork system with 7 supply and 1 return air registers on main floor and 4 supply and 1 return registers in basement. Supply registers to be floor-mounted near exterior walls. System capacity: 241 l/s (510 CFM).

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,350.00 |
| ELECTRICAL | 180.00 |
| PLUMBING | 0 |
| | $1,530.00 |

| | |
|---|---|
| GROSS COST: | $1,530.00 |
| LESS SAVINGS: | 1,458.00 |
| NET COST: | $ 72.00 |



NOTES:

1. The gas and electric furnaces are not of equivalent capacity but this is the smallest electric unit normally available.
2. Ductwork illustrated in Figure H-1.

SPACE HEATING H-6

SYSTEM: 8.00 kW electric baseboard heating system

SYSTEM DESCRIPTION:

o Install electric baseboard heating system:

| | |
|---|---|
| master bedroom | - 1000 W c/w wall-mounted thermostat |
| bedroom #2 | - 750 W c/w wall-mounted thermostat |
| bedroom #3 | - 750 W c/w wall-mounted thermostat |
| bathroom | - 500 W c/w integral thermostat |
| living/dining/kitchen | - 2500 W c/w wall-mounted thermostat |
| basement | - 2500 W ganged to one integral thermostat |
| Total Capacity | 8.00 kW |

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 0 |
| ELECTRICAL | 756.00 |
| PLUMBING | 0 |
| | $ 756.00 |

| | | |
|---|---|---|
| GROSS COST: | $ 756.00 | see Figure H-6 |
| LESS SAVINGS: | 1,458.00 | |
| NET COST: | $- 702.00 | |

NOTES:

1. Assumes 200 Amp service installed to meter and 100 Amp between meter and panel.

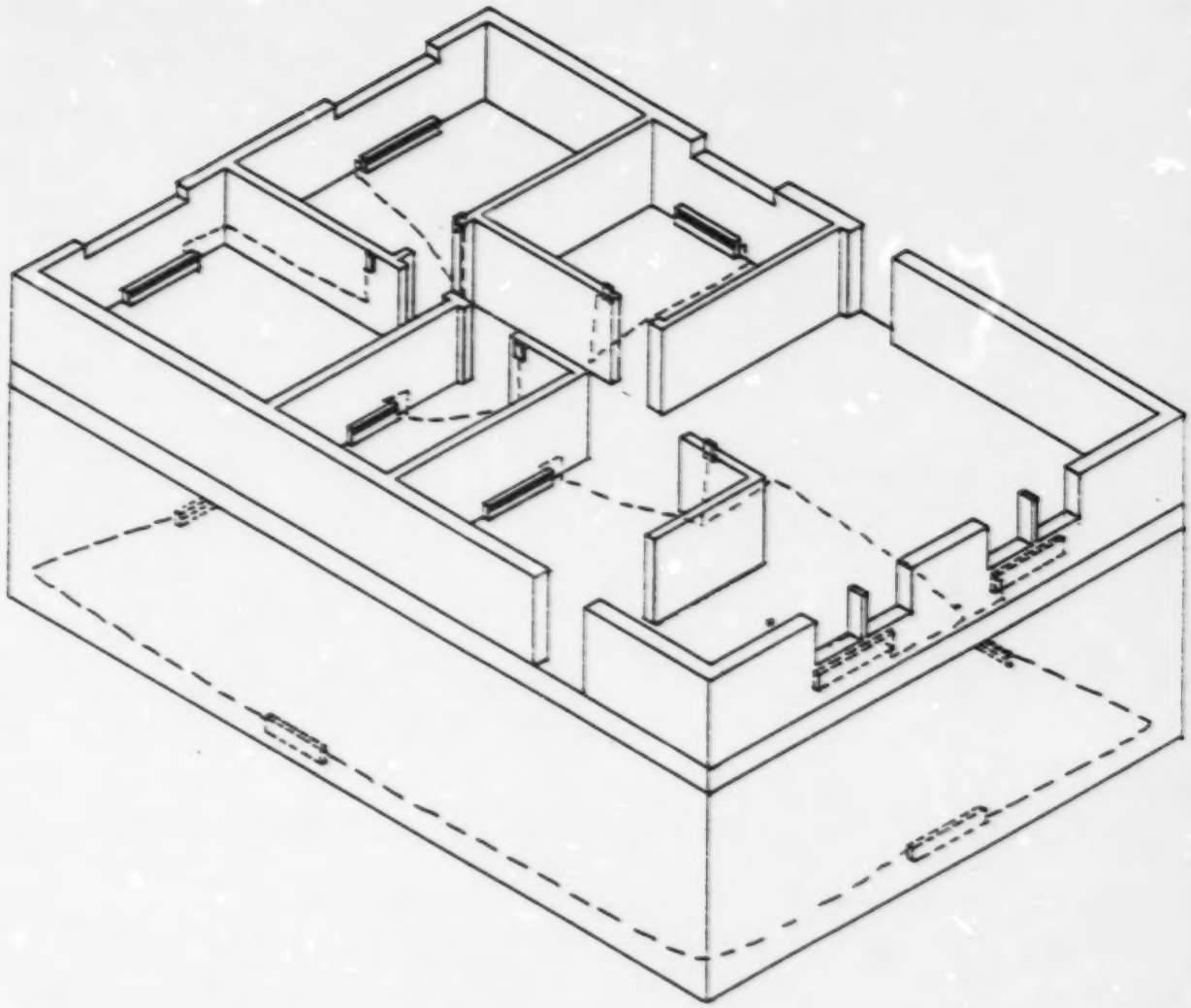


FIGURE H-6

SYSTEM: High sidewall supply registers, main floor

SYSTEM DESCRIPTION:

o Install 6 high sidewall supply registers in place of floor-mounted registers in:

| | | |
|---|---|---|
| master bedroom | - | 21 l/s (45 CFM) |
| bedroom #2 | - | 19 l/s (40 CFM) |
| bedroom #3 | - | 19 l/s (40 CFM) |
| bathroom | - | 14 l/s (30 CFM) |
| living/dining/kitchen (see note 1) | - | 47 l/s (100 CFM) |

GROSS COST:

| | |
|---|---|
| MECHANICAL | $95.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $95.00 |

see Figure H-7

NOTES:

1. Additional 26 l/s (55 CFM) is supplied to the living room through a floor-mounted register which architecturally could not be relocated into a partition wall.
2. Assumes no change to basement air supply.

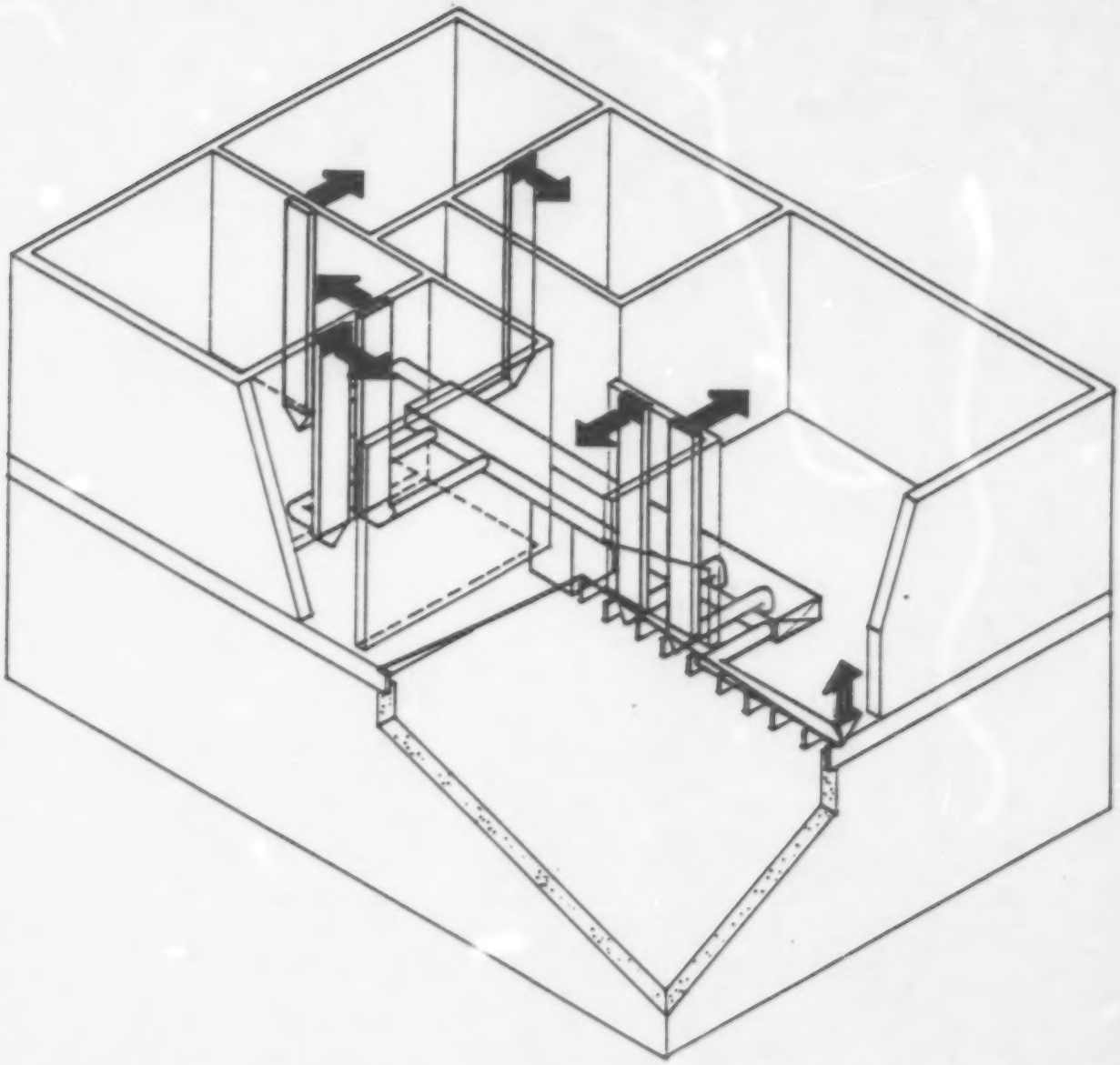


FIGURE H-7

SYSTEM: Individual room returns

SYSTEM DESCRIPTION:

- o Install additional room return air registers in:
  - master bedroom
  - bedroom #2
  - bedroom #3
- o Conventional system would use one return in hallway and one in basement.
- o Locate close to return air plenum (down centre line of house) to minimize costs.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $115.00 |
| ELECTRICAL | 0 |
| PLUMBING | 0 |
| | $115.00 |

see Figure H-8

NOTES:

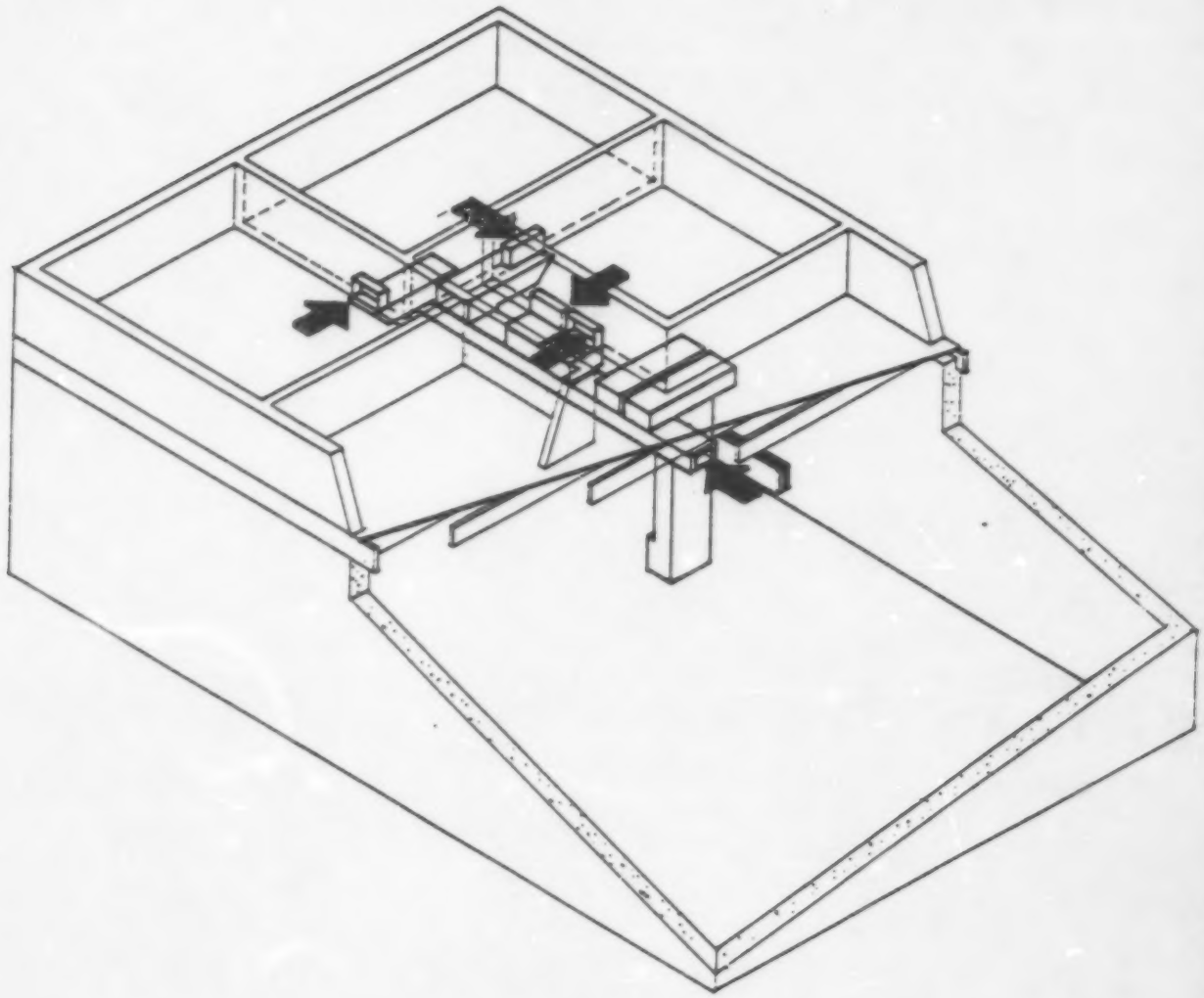


FIGURE H-8

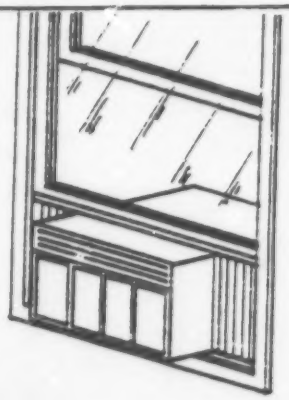
SYSTEM: Room air conditioner

SYSTEM DESCRIPTION:

o Install 0.8 ton window room air conditioner.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $600.00 |
| ELECTRICAL | 13.00 |
| PLUMBING | 0 |
| | $613.00 |



NOTES:

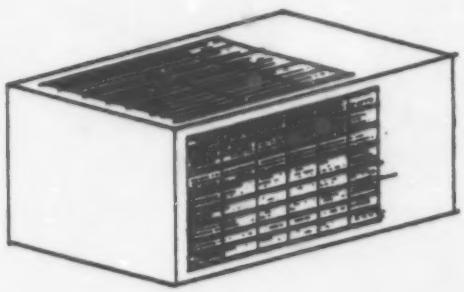
SYSTEM: 2 ton central air conditioning

SYSTEM DESCRIPTION:

- o Install 2 ton central air conditioner.
- o Ducting not included.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $1,900.00 |
| ELECTRICAL | 185.00 |
| PLUMBING | 30.00 |
| | $2,115.00 |



NOTES:

1. Includes $200.00 to increase capacity of ductwork to 378 l/s (800 CFM).

DOMESTIC HOT WATER HEATING D-1

SYSTEM: Conventional 114 l (25 I.G.) gas DHW tank

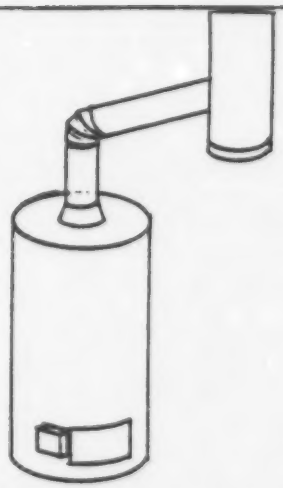
SYSTEM DESCRIPTION:

o Install 114 l (25 I.G.), 9 kW input (32,000 Btu/Hr) naturally-aspirated gas domestic hot water tank. Connect to existing vent.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 320.00 |
| ELECTRICAL | 0 |
| PLUMBING | 35.00 |
| | $ 355.00 |

| | |
|---|---|
| GROSS COST: | $ 355.00 |
| LESS SAVINGS: | 0 |
| NET COST: | $ 355.00 |



NOTES:

SYSTEM: Electric 182 l (40 I.G.) DHW tank

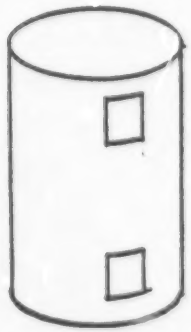
SYSTEM DESCRIPTION:

o Install 182 l (40 I.G.), 3000 W electric domestic hot water tank.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 300.00 |
| ELECTRICAL | 90.00 |
| PLUMBING | 35.00 |
| | $ 425.00 |

| | |
|---|---|
| GROSS COST: | $ 425.00 |
| LESS SAVINGS: | 355.00 |
| NET COST: | $ 70.00 |



NOTES:

SYSTEM: Electric 273 l (60 I.G.) DHW tank

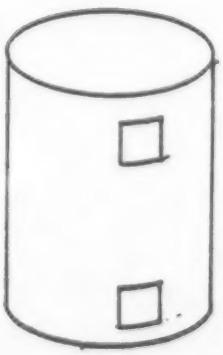
SYSTEM DESCRIPTION:

o Install 273 l (60 I.G.), 4500 W electric domestic hot water tank.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $ 400.00 |
| ELECTRICAL | 112.00 |
| PLUMBING | 35.00 |
| | $ 547.00 |

| | |
|---|---|
| GROSS COST: | $ 547.00 |
| LESS SAVINGS: | 355.00 |
| NET COST: | $ 192.00 |



NOTES:

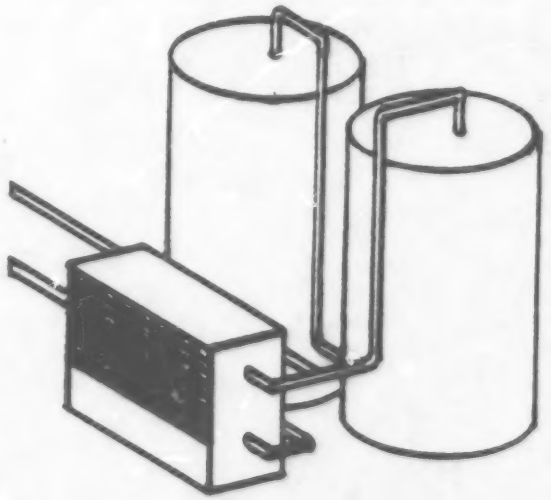
DOMESTIC HOT WATER HEATING D-4

SYSTEM: Heat pump DHW heater

SYSTEM DESCRIPTION:

- Install E-Tech Model 8108 heat pump water heater in basement and connect to existing DHW tank.

| | |
|---|---|
| GROSS COST: | |
| MECHANICAL | $1046.00 |
| ELECTRICAL | 8.75 |
| PLUMBING | 30.00 |
| | $1084.75 |
| GROSS COST: | $1084.75 |
| LESS SAVINGS: | 0 |
| NET COST: | $1084.75 |



NOTES:

1. All costs developed using August 1990 data.

SYSTEM: Habitair

SYSTEM DESCRIPTION:

- o Install Habitair integrated system which provides ventilation and DHW heating and degrees of supplemental space heating in winter and air-conditioning in summer. Unit consists of an exhaust-only ventilation system c/w integral heat pump to recover energy from the exhaust air which is used for DHW and space heating. In summer, heat is extracted from interior air to preheat DHW and provide a degree of air-conditioning. Heat pump cooling capacity is approx. 2.3 kW (8,000 Btu/hr) and DHW tank capacity is 273 l (60 I.G.) c/w 1,500 W of supplemental electric resistance heaters.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $5,000.00 |
| ELECTRICAL | 255.00 |
| PLUMBING | 100.00 |
| | $5,355.00 |

see Figure I-1

NOTES:

1. Habitair is intended by its manufacturer to ideally be integrated with the Fiberglas Canada Inc. Low Energy Home system which permits a leakier house envelope to be constructed.

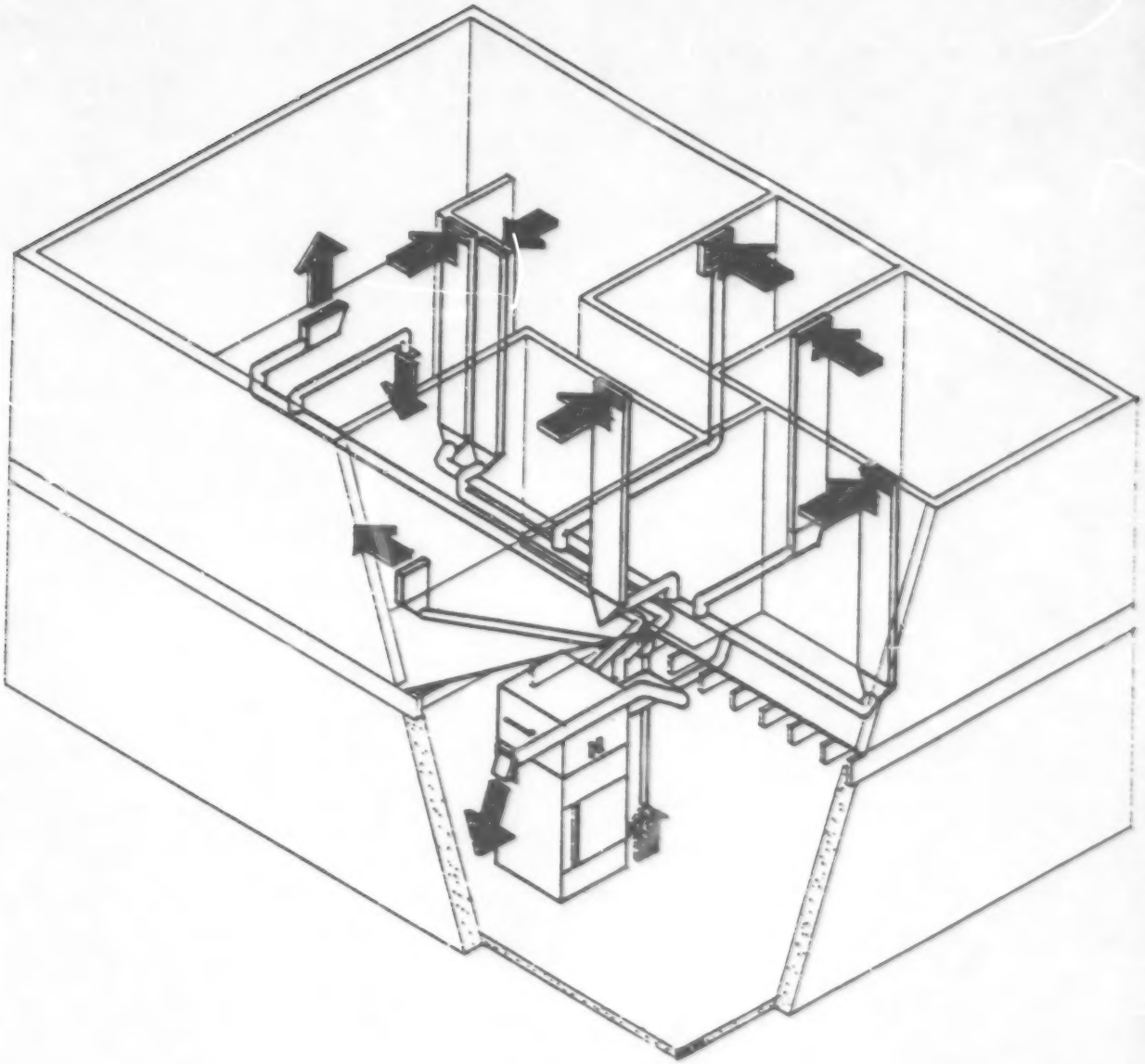


FIGURE I-1

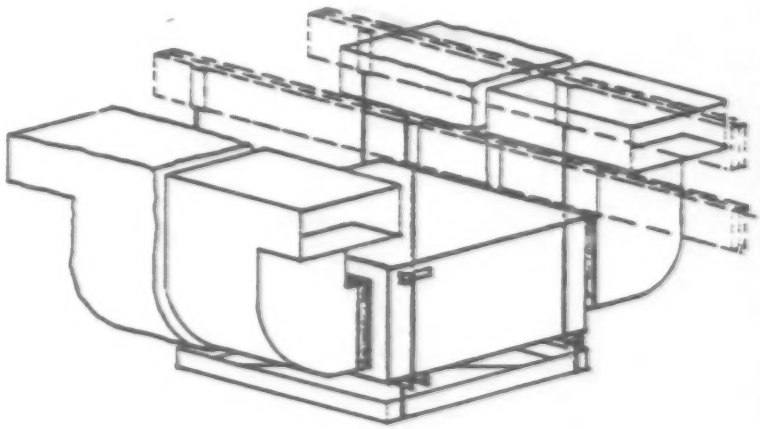
SYSTEM: Peach

SYSTEM DESCRIPTION:

- o Install Peach integrated system which provides space heating, DHW heating, ventilation and air conditioning. System consists of an integral 8 kW electric furnace, two electric DHW tanks 182 l (40 I.G.) and 114 l (25 I.G.), an integral air-to-air pump which recovers heat from outdoor and exhaust and a simple exhaust and supply ventilation system. Costs include all ductwork.
- o For cold climate applications, system requires supplemental exhaust system capacity from bathroom and kitchen fans.

GROSS COST:

| | |
|---|---|
| MECHANICAL | $5,460.00 |
| ELECTRICAL | 545.00 |
| PLUMBING | 220.00 |
| FRAMING | 100.00 |
| | $6,325.00 |



NOTES: